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THE OBERSPREE CENTRAL ELECTRIC STATION OF THE CITY OF BERLIN. TWO 1,800 TO 2,800-HORSEPOWER TRIPLE-EXPANSION ENGINES DRIVE TWO THREE-PHASE ALTERNATORS.

ELECTRIC LIGHT AND POWER AT BERLIN, GERMANY.*

By Frank C. Perkins.

The city of Berlin has a population of 1,888,000, and is excellently equipped with electric light and power stations, having a total capacity of 75,600 kilowatts. Both direct and alternating current systems are in operation, the former being arranged on the three-wire system, with storage batteries installed in many sub-stations for regulation and taking care of the peak of the load.

The accompanying illustration shows an interior of a portion of the Oberspree plant, one of the stations generating three-phase alternating current. This plant has a total capacity of 13,020 kilowatts. The two units shown each have a capacity of 2,300 horse power. These engines are of the triple-expansion type, constructed by the Actien-Gesellschaft Goerlitzer Maschinenbau Anstalt und Eisengiesserei of Görlitz. The speed is 107 revolutions per minute, the engines being supplied with steam at a pressure of 12 atmospheres. The three-phase alternators are directly connected, one on either side of the vertical engine, and were constructed by the Allgemeinen Elektricitäts-Gesellschaft of Berlin. A small flywheel is utilized in connection with the electrical generator to aid in the speed regulation, it being mounted between the alternator and the engine, as shown. The current from this station supplies directly, from the three-phase distribution line, 14,000 incandescent lamps of 50 watts each and 1,314 arc lamps of 10 amperes each, while the motor circuits supply current to machines having a total capacity of 9,540 horse power. The Oberspree plant also supplies current to two sub-stations, one at Marianenstrasse and one at Pallisadenstrasse, the former having a total output of 7,304 kilowatts and the latter 2,904 kilowatts. These sub-stations distribute direct current on the three-wire system at 220 volts and street railway current at 500 volts. The larger sub-station has a storage battery plant for reserve of 1,465 kilowatts, while the accumulator plant of the smaller sub-station has a capacity of 732 kilowatts. They supply current to 18,360 incandescent lamps and 7,620 respectively of 50 watts each. The commercial arc lamps served from these two sub-stations number 980 and 450 respectively of 10 amperes each. The motors used for commercial purposes in Berlin operated from the Marianenstrasse sub-station have a total output of 5,578 horse power, while those supplied with the current from the Pallisadenstrasse sub-station develop 1,991 horse power.

In the same way a number of sub-stations are supplied with three-phase current from the Moabit power station, which has a capacity of 9,000 kilowatts. The Voltastrasse sub-station has an output of 5,368 kilowatts, while the Wilhelmshavenerstrasse sub-station is equipped with apparatus having a total output of 1,936 kilowatts. There are 96,000 incandescent lamps operated from the Konigin-Augustastrasse sub-station alone, the latter having a storage battery plant of 1,880 kilowatts.

The total capacity of the various storage battery plants used in the sub-stations and power house of the Berliner Elektricitätswerke is 13,742 kilowatts, and the central stations of the city supply the necessary current for lighting nearly half a million (459,180) incandescent lamps of 50 watts each; while the arc lighting service of the city is supplied with current for 15,683 arc lamps of 10 amperes each. Electric motors are quite extensively used for factories and other business places in Berlin, the total power developed by the electric motors being 38,409 horse power.

In the Oberspree power station there are, in addition to the vertical engine above mentioned, a number of triple-expansion compound engines of the horizontal type, constructed by the Actien-Gesellschaft Goerlitzer Maschinenbau-Anstalt und Eisengiesserei of Görlitz, operating at a speed of 87 revolutions per minute. These engines are supplied with steam at a pressure of 14 atmospheres, and develop 3,000 to 4,000 h. p. each. At the Centrale am Schiffbauerdamm there are in operation two vertical compound engines of the Görlitz type, operating at a steam pressure of 10 atmospheres and developing from 1 500 to 2,000 horse power at a speed of 105 revolutions per minute. Until recently the horizontal reciprocating engine seemed to be the favorite with German engineers for central power stations, but a large number of vertical machine type of engines are now in operation, which have given excellent satisfaction.

The steam turbine is now being introduced in Germany and other European countries extensively in sizes up to 5,000 kilowatts, and the steam consumption is very low. At the Frankfort central station a Parsons steam turbine directly connected to a three-phase alternator supplied 2,995 kilowatts with a steam pressure of 10.6 atmospheres and a superheat of 312 deg. C., the steam consumption being only 6.7 kilogrammes per kilowatt hour.

The high-power gas engine is also now competing successfully against the steam engine for central station work, it being far more economical in operation, and is particularly valuable where waste blast-furnace gases are obtained, as iron and steel plants.

According to a recent issue of the Journal de St. Pétersbourg, the survey of the proposed line between Kiakhta and Pekin, *via* Ougra—1,500 versts—has been completed.

* Specially prepared for the Scientific American Supplement.

THE KANSAS RIVER FLOOD.

By Charles Alma Byers.

The annual geological survey report of the University of Kansas, just issued by Prof. Erasmus Haworth, State Geologist, contains a very valuable and interesting chapter on the exceedingly damaging flood of the Kansas River, which occurred during the last of May and the first few days of June of 1903. The chapter is the result of a thorough examination made by Prof. Haworth and six assistants of all the river valleys lying between Junction City and Kansas City, and is for the purpose of showing the changes made in the river channel, the washings of land areas, the deposits of sand and silt, etc. Accompanying the work are a number of maps intelligibly portraying these findings, and a study of them reveals some peculiar results of this flood which proved so disastrous in the loss of life and property.

In the way of sand and silt deposits we observe from the maps that the distribution was quite general throughout the whole distance of the river considered, and that these deposits are almost always made on the concave side of the curves in the river channel. The report tells us that the amount of this material deposited would probably equal a film four to six inches deep all over the entire valley; that in some places it reached a thickness of five or six feet, and that frequently over a forty-acre field of alfalfa it would be from two to four feet, while over almost all the remaining part of the valley it would range in thickness from two to six inches. This naturally completely destroyed many valuable farms and at the same time enriched many that hitherto had been poor.

A glance at the maps also shows that many great changes have been made in the river's channel; that it has been quite materially shortened by cut-offs. To note these, let us start at Junction City and pass downward to Kansas City. The first is observed to be where the river makes a great turn to the south, about four miles above Manhattan. The high water, instead of following the old channel in its sharp turn southward, went straight across, making a new channel of two miles in length. This cut-off shortens the old course by two miles and creates an island aggregating from 900 to 1,000 acres. Just below the mouth of this new channel a second one is cut. This channel is a mile in length while the length of the old one is three miles; thus two more miles are saved. The island formed by this cut-off contains between 400 and 500 acres.

After leaving Manhattan no more cut-offs are found until St. Marys is reached. Here something very uncommon will be observed. Just south of the city is a broad, bold curve in the river between four and five miles across. A new channel, or cut-off, of two and a half miles is formed here. Just beyond and immediately south of St. Marys a second new channel a little less than a mile in length cuts across the second ox-bow curve in the river. As a result, the water at the present time "flows through the first new channel mentioned, enters the old channel at the most western point of the ox-bow curve, flows through this old channel a distance of two miles, but *in the opposite direction* of the old current, then through the second new channel and into the old river." This is a unique result and something probably without a precedent. To the citizens in this vicinity the river seems to be flowing up-hill; and it is a fact that it flows for a distance in a direction opposite to its former course.

Passing on, we come to another new channel just before reaching Rossville. This new channel, a mile in length, takes the place of an old one of about three miles in length, and creates another island of several hundred acres. Again we can make another long jump, for no more cut-offs appear until we come to Lake View, where we find the sixth and last. This is a very short one but the new channel greatly shortens the old one.

In addition to the complete formation of these six new cut-off channels, in several places along the river are found deep current washings, or new channels only partly cut. Such are to be seen near Wamego, Belvue, Kingsville, Tecumseh, Fall Leaf, and Desoto. Then, too, just south of Silver Lake we find another result of current washing or cutting. At a bold curve here the current struck the bank of the river at right angles and wore away from 125 to 150 acres of good valley land by a process which only widened the river channel. Near Topeka and at Lake View the land was greatly and similarly corraded, and with almost equal damage.

Commenting upon the observations he has made of the existing conditions along the Kansas River as produced by the flood of last year, Prof. Haworth offers some valuable suggestions. Preliminarily he says: "Had the laws of nature been such that streams normally produce and maintain straight channels, or had some great work of man straightened the course of the Kansas River previous to this flood, we may well believe the destruction of life and property, of fields and farms, would not have been half what it actually was; for an examination has shown that more than ninety per cent of the damage done to farm lands was directly connected with sharp curves in the river channel."

Within his knowledge, he says, this is a subject never considered seriously by engineers. He then continues: "It occurs to the writer that possibly there may be greater wisdom in this idea of straightening river channels than has generally been considered. As population increases in our fertile valleys and wealth greatly accumulates, this question may be given more attention, for protection against flood devastation gradually will become more important. Ultimately our engineers may give it serious attention, and determine whether or not it is feasible to go to the expense of compelling rivers to occupy straight channels. For, when once straightened, the expense is by no means ended. If rivers naturally meander from bluff to bluff in their flood-plains, there must be some great law producing and controlling such meanderings. Fortunately, geologists have studied rivers, and have determined to a great extent such laws, so that to-day, in any standard text-book on physical geography or geology, the outlines of such laws and such processes are given in so elementary a manner that anyone may understand them.

"A long, straight channel could remain straight only under one of two conditions. If the materials composing the two banks were entirely homogeneous, so that resistance to the cutting power of the water were absolutely uniform on both sides throughout the entire life of the river, then the channel might remain straight. Or, if artificial means were resorted to which were sufficiently powerful to prevent the current from cutting either bank, likewise the channel would remain straight. It is a question of engineering but little studied how best to accomplish this second condition. Possibly the building of cheap but substantial jetties, similar to those so frequently found along the Kansas River between a railroad track and the water, might accomplish the purpose. But no river can have a channel either natural or artificial with the two banks entirely homogeneous. Here will be greater resistance to erosion than there, caused by a firmer bed of clay, a buried log or snag, or some other object, great or trivial, which will deflect the channel against a soft place in the opposite bank. When once begun, the constant striking of the current against the bank will as constantly wear it away, for flood-plains, being of an alluvial nature, are easily corraded. Soon there is a pronounced curve in the channel which is ever intensified, because water flows the swiftest on the convex side of the curve, where it must travel the fastest in order to accomplish its journey. Its excessive velocity makes it possible to corrade a bank more and more, while the decreased velocity on the concave side at the same time causes a building up of a sand-bar or mud-bar, which follows with equal pace the wearing into the bank on the convex side.

"The angle of curvature of a stream is dependent upon the size of the stream. In little rivulets and rills these ox-bow-like curves may be no more than twenty or thirty feet apart, while in great rivers like the Missouri and the Mississippi they are miles. Neither is there perfect regularity in their frequency. A detailed map of any stream will show that there is the greatest variation in this respect. Streams at average stages, and when slightly flushed, are constantly increasing the intensity of such curves. But when the great floods come, and the waters flow over the banks and cover the whole valley, then the principal current follows a straighter course, often cutting new channels across the narrow necks of land, leaving the old curved channel in the form of a lake or bayou. Waters at moderate stages and mild floods, therefore, produce crooked channels, but great floods tend to straighten them.

"One of the most remarkable features of the recent flood in the Kansas River valley is the pronounced tendency to straighten the course by forming new channels across the openings of the old curves. A study of the accompanying maps shows at a glance that here is where the great sand masses accumulated, implying swift currents of water; or where the most cutting or gorging and channeling of farm lands was accomplished, implying swifter currents; or, still farther, where all the new channels were formed, implying the greatest velocities. Throughout the whole distance studied there is not a single instance of a new channel being formed on the convex side of the curve. Every one so produced is on the concave side, and has resulted in shortening the length of the stream and straightening its course to some extent. Still further, every instance in which severe cutting was done, but too mild to change permanently the river channel, likewise was on the concave side of a curve, so that had the cutting been greater it would have shortened the river by straightening the channel. With such observations as these, one cannot help asking whether or not it would be the part of wisdom to bring artificial means to help straighten the river. Certainly the changes produced in the Kansas River valley by the recent flood constitute a great object lesson."

The rainfall during the spring and early summer of 1903 which caused this flood along the Kansas River was unusually great and unusually distributed. Summarized, the reports of the United States signal office at Topeka of the precipitation for the month of April show the maximum at different points to be as follows: Lakin, 5.51 inches; Garden City, 5.10; Pleasanton, 4.83; Farnsworth, 4.51; Leoti, 4.25; Russell, 4.24; Newton, 4.15; and Delphos, 4.02. Similar reports from twenty-nine other stations show the rainfall to have varied between three and four inches, while at about sixty remaining places it was less than three. There is nothing very striking about the precipitation of this month, but notice the reports for May. Salina had 17.34 inches; Republic, 17.13; Frankfort, 16.34; Columbus, 14.47; Grenola, 14.33; Hanover, 14.25; Harrison, 13.70; Clay Center, 13.36; Horton, 13.32; Pittsburg, 13.20; Concordia, 13.15; Wamego, 13.11; Holton, 13.09; Atchison, 12.48; Oswego, 12.04.

The same unusually great rainfall was reported from nearly all the remaining stations of the State, and at Salina 5.25 inches of water fell in a single twenty-four hours. As the largest part of this record-breaking precipitation fell in the drainage area of the Kansas River, the flood is easily accounted for.

MERCANTILE FLEET OF JAPAN.

UNDER date of December 10, 1903, United States Consul S. S. Lyons, of Kobé, Japan, transmits the following extract from the Kobé Journal of December 9:

"A number of statistics relative to the development of the Japanese merchant marine have appeared in the Tokyo Keizai. It was in 1870 or thereabout, the journal recalls, that the Japanese began to turn their attention to the carrying trade, in the modern sense of the term, but its growth was slow until the Chinese war of 1894-95. The following table gives the figures for the eleven years from 1892 to 1902, inclusive:

Year	Tons.
1892	214,000
1893	325,000
1894	320,000
1895	386,000
1896	417,000
1897	486,000
1898	648,000
1899	796,000
1900	863,000
1901	917,000
1902	934,000

"From the comparative statistics published in the journal, it is seen that, while in 1892 the Japanese mercantile fleet was the thirteenth in the world in point of tonnage, it had risen by 1901 to the eighth position, and it is interesting to note that it is rapidly coming up to the same relative status as that occupied by the Japanese navy, now seventh among the navies of the world. In the same journal there is an interesting article by Capt. Hirayama, I. J. N., director of the Nautical College, in which the writer discusses the relative positions of foreigners and Japanese in the Japanese merchant service. Capt. Hirayama expresses the opinion that it is of great importance to Japan that her mercantile marine should be under the command of her own officers. That this truth was early appreciated by Japan was shown by the strenuous efforts made by her to procure a supply of well-educated officers. The growth of the merchant service, however, has been so rapid that the supply of well-trained officers has not kept pace with the demand. According to statistics obtained by Capt. Hirayama from the Nippon Yusen Kaisha, and carefully digested by him, the total numbers of officers on that company's European, Australian, American, Bombay, and Shanghai liners was 293, of whom 184 were Japanese and 109 foreigners. On closer examination of the statistics it is found that the higher ranks of the service are almost monopolized by foreign officers, as is shown by the following table:

Officers.	Foreign.	Japanese.
Commanders	22	5
Chief engineers	21	6
First officers	23	4
First engineers	13	14
Second officers	10	17
Second engineers	16	30
Third officers	3	46
Third engineers	1	62

"The Australian and European lines are all commanded by foreign officers, whereas one steamship on the American and one on the Shanghai line are under Japanese captains, who are graduates of the Nautical College. Of the foreign lines mentioned above, the only one exclusively officered and manned by Japanese is the Bombay service. As for the same company's other foreign lines—namely, those of North China and Vladivostock, as well as the coasting services—they are for the most part officered by Japanese. So also are the ships owned by the Osaka Shosen Kaisha and other companies."

THE ELECTRIC FURNACE IN METALLURGY.*

By ALBERT HELLER.

THE temperature of the electric furnace is easily controlled during fining by the adjustment of the electrodes by hand. It can be increased to a point far above the temperature of the open-hearth furnace, converter, or crucible furnace, and it is even possible to obtain a heat sufficient to volatilize the iron. By the process of electric fining, reactions can therefore be produced which are impossible in the open hearth. The process is carried on in the same manner as in the open hearth, that is, the same oxidizing agents are used, but the salient advantages are due to the mode of heating, which is neutral, and to the generation of heat above and on the surface of the molten metal. These are two essential points which, from the metallurgical point of view, constitute the difference between the method of fining by electricity and that currently employed. For this reason the steel obtained by a rational electric process, combined with modern metallurgical practice, is possessed of properties comparable with those of crucible steel. The decarburization should be effected preferably with the aid of metallic oxides, in particular with oxide of iron. If a blast is employed a rapid waste of the electrodes ensues; further, the oxygen of the air blast, after burning the greater portion of the more oxidizing elements, of which carbon is the chief, then reacts upon the iron, forming particles of oxide of iron which, being disseminated throughout the mass, rapidly change its quality. On the other hand, the oxygen of the oxide of iron, being in stable combination, is only freed by the energetic reducing action of the carbon. The ore process, therefore, appears to be that which is best applicable to the electric open hearth.

The dephosphorization and desulphurization of the metal bath are also facilitated by the character of the source of heat. The elimination of sulphur can be effected without difficulty owing to the ease with which a reducing action is promoted. Otherwise the conduct of the operation of fining by the electric method presents no further points of sufficient interest to report. The formation and removal of the slag also present no particular features of interest. Slags differing in character are of course formed successively where desulphurization takes place.

The final additions are made as in the ordinary process. The only point to be noticed in regard to these is the economy which can be effected in the case of rare metals by the prevention of loss due to their oxidation while making the additions.

For the application on a large scale of the process just described the furnaces should be placed in line, just abreast to each other. Two fining furnaces are preferably arranged in front of each smelting furnace, each of which will receive the metal alternately, while fining is being completed in the other. A more practical arrangement suggests itself in cases where a large amount of power is available. The charges of all the reducing furnaces could be run off into a single ladle on a bogie traveling along the front of the battery of furnaces. The metal thus collected could be fined direct by bringing the ladle beneath an arrangement of electrodes similar to that described, or it might be teemed into a fining furnace of a capacity sufficient to receive the whole. Two such furnaces would then serve the whole battery of smelting furnaces; for if the latter were tapped every three hours, there would be six hours available for fining, tapping and repairing the hearth and walls.

An electric metallurgical works laid out on this plan, having a force of 10,000 horse power on the shaft of the turbines, could produce sixty tons of steel per day, of which fifty tons would be yielded by the smelting furnaces working on 55 per cent ore and ten tons by the smelting of scrap. As far as possible the power should be generated by alternating monophase dynamos subdivided into groups of 1,000 horse power each. Of these, eight would supply current to the smelting furnaces, and the other two would be devoted solely to the operation of fining.

* Abstract Proceedings of Iron and Steel Institute.

PROF. SLABY'S EXPERIMENTS IN WIRELESS TELEGRAPHY.

THE well-known experimenter in the field of wireless telegraphy, Prof. Slaby, has been granted the sum of $5,000 for continuing his researches. We now learn that in connection with the Berlin Wireless Telegraph Conference, a preliminary report has been presented. The experiments first dealt with the question as to the part played by the earth in connection with wireless telegraphy. By means of extensive zinc armatures on the ground of his laboratory, the author was able to construct a sort of artificial earth, and to study the propagation of electric waves along the ground, when he announced the presence of stationary waves, giving evidence of the important rôle played by the conductive surface of earth. The theory of closed sending apparatus was not so far able to account for the distance effects of such sender types. Prof. Slaby now succeeds in reducing them to the action of the upper harmonics and in establishing a novel theory, the results of which are in a most satisfactory accord with experiments. The author further dealt with the design of instruments enabling even unskilled persons to measure the wave length of a transmitting station. About a dozen different types have been experimentally studied and shown to be fully suitable. The author, we learn, is at the present moment engaged in studying new transmitter types, it being anticipated that a better method of tuning different stations will be derived from these experiments, which are shortly to be recorded in an extensive treatise. A. G.

[Concluded from SUPPLEMENT No. 1466, page 23493.]

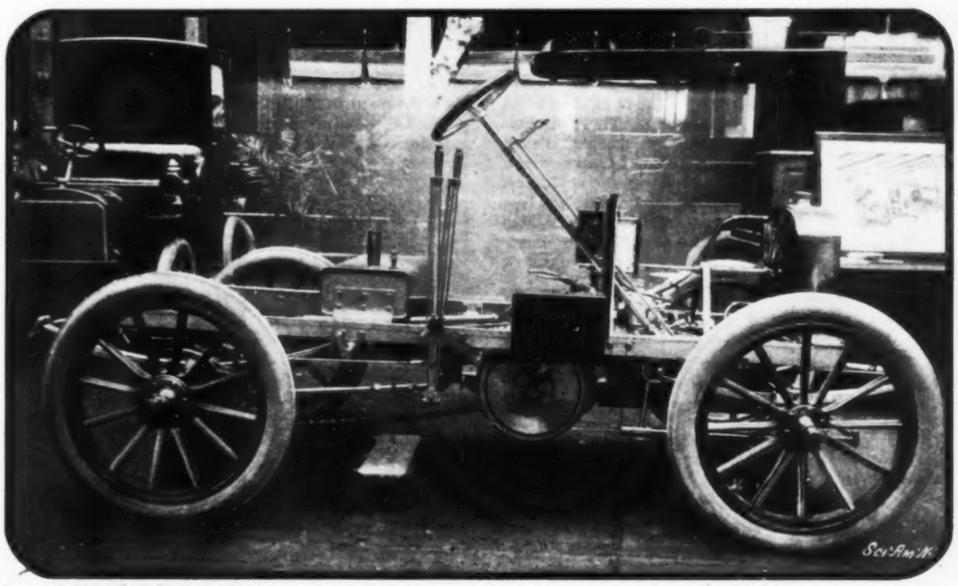
THE PARIS AUTOMOBILE SHOW.—III.

By the Paris Correspondent of the SCIENTIFIC AMERICAN.

THE MOTOBLOC CAR.

THE novel feature of this machine is a combined engine and transmission gear. The latter part of the car's mechanism is contained in one end of the motor crank case, which is enlarged to receive it, as shown in the diagram. The other two views show the inclined motor, looking at it from the transmission side and showing the large cone clutch in the foreground and the motor flywheel on the other side; and the motor mounted on the chassis, with its direct drive by a chain to the rear axle.

The two cylinders of the engine are formed of a single casting and are bolted to a special crank case having lugs on it so placed that the motor, when mounted on the chassis, shall rest at an angle of about 45 deg. with the vertical. The motor has large, suction-operated inlet valves on the upper side of the cylinders, located in the circular chambers, l_1 l_2 (see diagram). The exhaust valves are located diametrically opposite the inlet valves, on the under side of the cylinder, and are operated by bell cranks indicated by dotted lines within which letters l_1 l_2 are placed. The ends of the bell cranks in the center of the circular valve hole push directly on the exhaust valve stems, while the other ends are shown attached to the cam-raised rods, L_1 L_2. The bell cranks are pivoted on a suitable bracket below the motor. The exhaust valves are large and they can be readily removed, together with their seats, for grinding. Spark plugs are fitted in the ends of the cylinders at i.



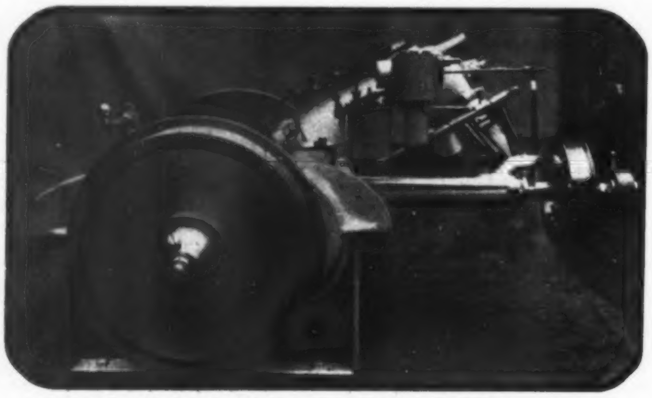
CHASSIS OF MOTOBLOC CAR, SHOWING DIRECT CHAIN DRIVE FROM MOTOR TO REAR AXLE.

The carbureter, C, is bolted to the cylinders and supplies them with gas through a chamber in the cylinder casting leading to the inlet valves. The carbureter is fitted with a throttle valve consisting of a perforated rotatable disk placed beside a similar stationary one. The governor moves the disk slightly and causes the holes in it to mis-match with those in the stationary one. The governor is on a vertical shaft, which is revolved by means of a spiral gear on the secondary shaft of the transmission (between gears b and Y) meshing with a worm gear on said shaft (indicated by two broken circular lines).

In the transmission case forming the enlarged part of the motor crank case, there are the two usual shafts of a sliding gear transmission. The main one, F, has its left-hand end in a bearing in the end of the motor crank shaft, while near its right-hand end it is supported in a ball bearing in the case. F is squared so that the gears k and J_2 can be slid on it by means of fork X, and can also turn it when they are driven. On the right-hand end of F is adjustably screwed a hub, N, which carries the clutch cone, Q_1. The outside clutch ring and drum, Q, Q_2, is attached to a sleeve running on a ball bearing, B_2, and carrying the driving sprocket. The coiled spring that keeps the clutch engaged is seen at r, and the ball bearing thrust ring at B_3.

The motor crank shaft, A, has a flywheel, V, bolted to a disk, c, on it near its left-hand end, while cut on its other end is a spur gear having miter teeth, a, on its right-hand side. These teeth engage in notches in the side of K when the sliding set, k and J_2, is moved as far to the left as possible. This produces a direct drive and gives the high speed. The secondary, or lay shaft, of the transmission is always running at half the speed of the motor, and is thus made to serve as the half-speed cam shaft of the motor (the valves of

which it operates through cams K) as well. It is revolved by gear J_1, which is always in mesh with gear a. It has fastened to it three gears, the one farthest to the right being constantly in mesh with an intermediate pinion, O, for producing the reverse. In the position shown, the reverse gear is thrown in, as J_2 is in mesh with O. By sliding k J_2 to the left till J_2 meshes with Y, the slow speed is obtained, the drive being from gear a to J_1 and from Y to J_2. The middle speed is obtained through a J_1 b k. By the arrangement shown, the main disconnecting clutch is placed between the transmission gear and the rear axle, instead of between the motor and the transmission, as is the usual practice.



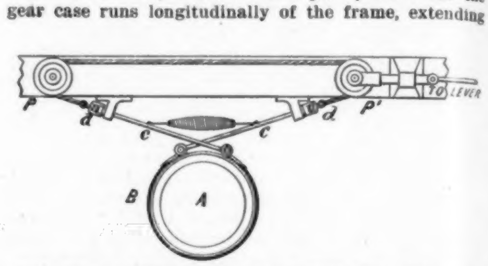
SIDE VIEW OF MOTOBLOC MOTOR, SHOWING CONE CLUTCH ON END OF PROLONGED MOTOR SHAFT.

SOME FEATURES OF THE LOUET CARS.

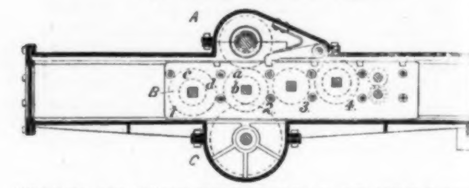
The two chassis exhibited by Mons. E. Louet were fitted with a single cylinder and a triple cylinder motor respectively, used in connection with that inventor's novel change-speed gear, a diagram of which is shown herewith. The former motor was of 6 horse power, and the latter of 18. A sextuple cylinder engine fitted with two carbureters was also shown. These motors all have mechanically operated inlet valves placed each alongside of its corresponding exhaust valve, in a single valve chamber on one side of the cylinder. Besides the regular jump spark plug in the valve chamber above the inlet valve, each cylinder is also fitted with an auxiliary plug in the cylinder head. The two plugs are in series, and one acts as a spark gap to the other.

The change-speed gear consists of a rectangular box having fixed gears A and C and a number of slidable gear sets 1, 2, 3, 4, consisting of two gears each of varying sizes, as a b, c d, etc. All these gear sets are mounted on short shafts in a carrier, B, that slides lengthwise in a frame contained in the gear casing. As B is moved along, the different sets of gears are brought into contact with the driving gear C (connected with the motor through the usual flywheel clutch), and with the driven gear, A (which drives the rear axle through a universally-jointed shaft with bevel-gear drive). The different speeds are thus obtained, and as the gears are always brought into mesh face on, instead of being slid into mesh sideways, there is little or no danger of the teeth chipping or breaking, or of the parts getting out of line. So well distributed are the strains on the gear case, that a sheet steel casing 0.078-inch thick is sufficiently strong to contain a 30-horsepower transmission. Besides all these advantages, the gear offers the still greater one that, by simply unscrewing four thumb-screws and taking off the end cap of the casing, the gear carriage and all the gears may be drawn out and inspected.

On the single cylinder chassis the above described transmission gear is placed transversely of the frame, so that the shaft of gear, C, is in line with the motor shaft and that of gear, A, is connected through a universal joint to the longitudinal driving shaft extending to the rear axle; but on the triple cylinder car the gear case runs longitudinally of the frame, extending forward from the rear axle. In this case A is attached to the casing of the differential on the counter-shaft, and C is driven through bevel gears by a longitudinal shaft projecting backward from the flywheel clutch.

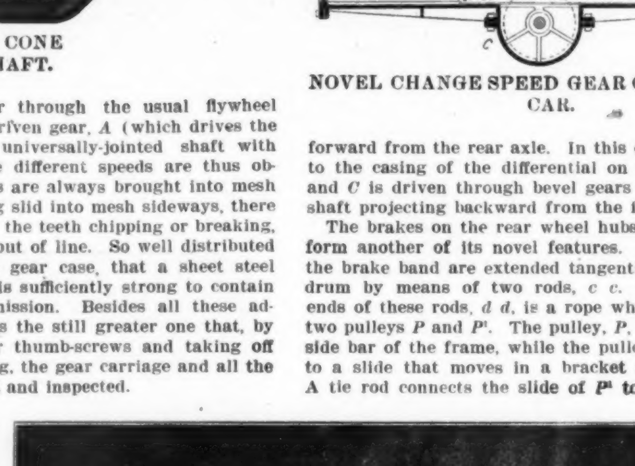


DOUBLE-ACTING, SELF-ADJUSTING BRAKE ON THE LOUET CAR.



NOVEL CHANGE SPEED GEAR OF THE LOUET CAR.

The brakes on the rear wheel hubs of the Louet car form another of its novel features. The two ends of the brake band are extended tangentially to the brake drum by means of two rods, c c. Fastened to the ends of these rods, d d, is a rope which passes around two pulleys P and P^1. The pulley, P, is fastened to the side bar of the frame, while the pulley, P^1, is attached to a slide that moves in a bracket on said side bar. A tie rod connects the slide of P^1 to the brake lever. When the lever is operated and P^1 is moved forward, it tautens the rope and makes it pull equally on the brake band from each end, with the result that the brake will hold equally well with the machine moving backward or with it moving ahead.

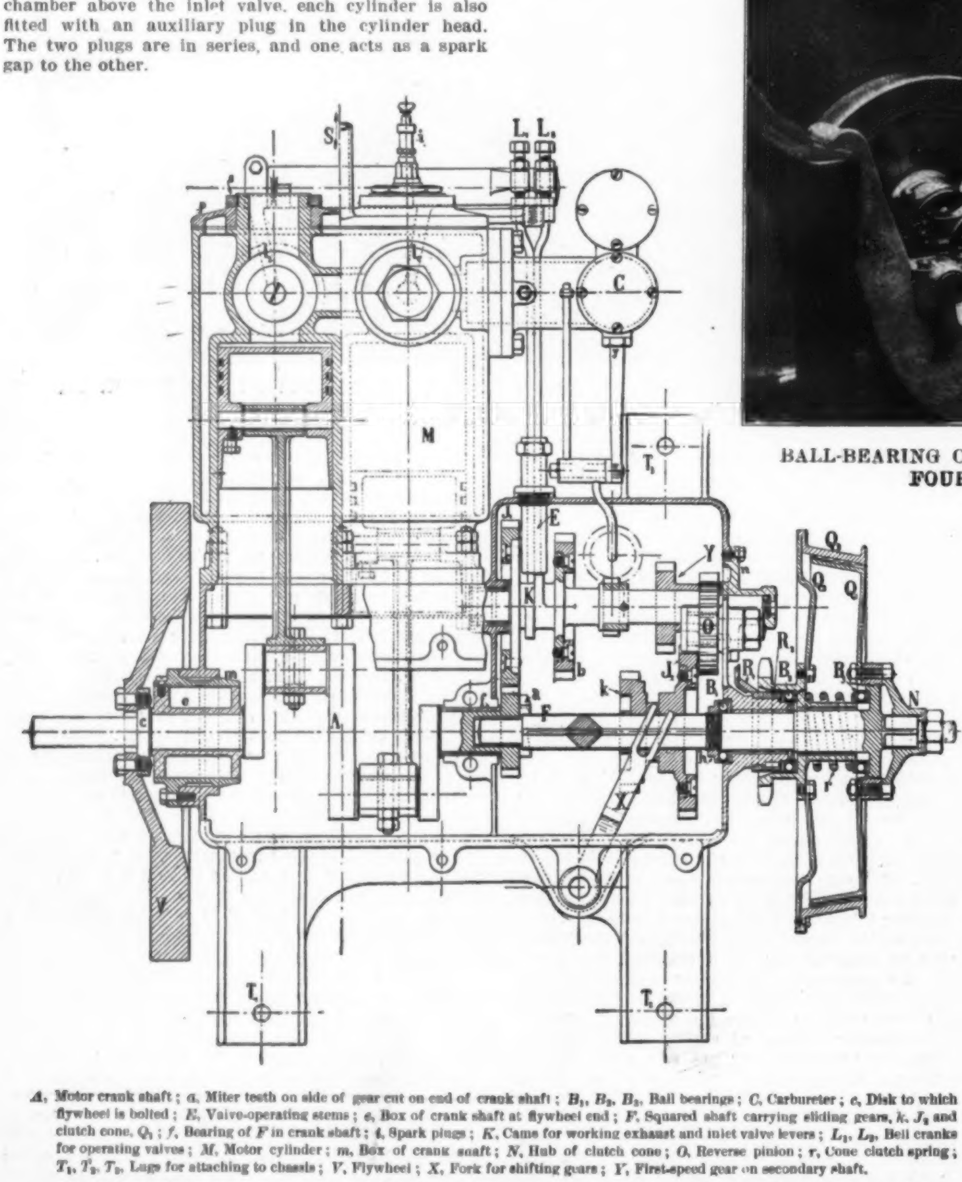


BALL-BEARING CRANK SHAFT OF THE HOTCHKISS FOUR-CYLINDER MOTOR.

THE HOTCHKISS CAR.

One of the machines that attracted a great deal of attention was the new car built by the well-known makers of the Hotchkiss rapid-fire gun. One of the chief novelties in the construction of the motor is its ball-bearing crank shaft, which we illustrate. Ball bearings are also fitted in the transmission gear and wheels of this car. The use of ball bearings throughout, therefore, is one of the features of the Hotchkiss car. The makers claim that these bearings are so constructed that all the balls receive an equal pressure, thus greatly diminishing the risk of breakage. The bearings appear to be unadjustable, and to be employed merely to reduce friction and wear. The Daimler Company have used this type of ball bearing successfully the past year in the transmission gear of their Mercedes cars, but whether it will stand up under the shocks of the explosions in a gasoline motor remains to be seen. The motor is fitted with mechanically-operated inlet valves and a novel automatic carbureter in which the proportions of the explosive mixture are kept the same at all speeds.

The gears used in the sliding-gear transmission are much smaller than those ordinarily employed, and they are cut from extremely hard nickel steel. The car has four speeds, with direct drive on the fourth. It is impossible for the gears to slip out of mesh from vibration or other cause, as a strong horizontal spring, fitted with a key, drops into a slot when the teeth are in mesh and always keeps the gears in position.



A, Motor crank shaft; a, Miter teeth on side of gear cut on end of crank shaft; B_1, B_2, B_3, Ball bearings; C, Carbureter; c, Disk to which flywheel is bolted; E, Valve-operating stems; e, Box of crank shaft at flywheel end; F, Squared shaft carrying sliding gears, k, J_2 and clutch cone, Q_1; f, Bearing of F in crank shaft; i, Spark plugs; K, Cams for working exhaust and inlet valve levers; L_1, L_2, Bell cranks for operating valves; M, Motor cylinder; m, Box of crank shaft; N, Hub of clutch cone; O, Reverse pinion; r, Cone clutch spring; T_1, T_2, T_3, Lugs for attaching to chassis; V, Flywheel; X, Fork for shifting gears; Y, First-speed gear on secondary shaft.

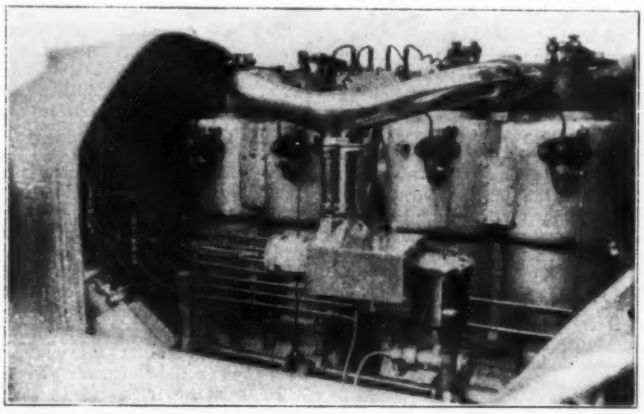
CROSS-SECTIONAL PLAN VIEW OF COMBINED MOTOR AND TRANSMISSION ON MOTOBLOC CAR.

The case of the differential gear is divided horizontally instead of vertically, and the top half may be readily removed, exposing the gear.

The Hotchkiss cars are fitted with round honeycomb radiators, which gives them an extremely odd appearance and makes them look as though they had a small horizontal boiler in front.

THE 90-HORSEPOWER MERCEDES CAR.

The illustration shows the inlet-valve side of the 90-horsepower, four-cylinder Mercedes motor on the powerful touring car and racer brought out this year by



THE 90-HORSEPOWER MOTOR OF THE NEW MERCEDES CAR.

the Daimler Company, and first exhibited at the Paris Show.

The large number of water pipes for properly distributing the water from the cellular radiator to the water jackets of the two pairs of cylinders is one of the novel arrangements of the car. The carbureter and throttle is seen at the end of the large gas inlet pipe. The float-feed chamber of the carbureter is a vertical cylinder on the right of the rectangular mixing box, which contains a piston throttle valve, the casing of which protrudes on the left of the box. The operating lever of the throttle valve is also visible. The four make-and-break igniters are seen in the sides of the cylinders. The rods which operate them are worked by eccentrics on the half-speed shaft seen at the bottom of the picture. The inlet valves are operated by levers seen on top of the cylinders. The wires from the insulated poles of the igniters end in plugs on top of the motor, by removing which it is possible to tell very easily which cylinders are firing.

The record of a mile in 39 seconds recently made by W. K. Vanderbilt, Jr., the owner of the first of these machines, is the fastest time that has ever been made on an automobile.

THE THURY GASOLINE-ELECTRIC AUTOMOBILE.

The day when electric accumulators become longer-lived and lighter, especially for a given capacity, electric automobiles will, without doubt, dethrone steam and gasoline machines. Their faultless running, noiselessness, and freedom from odor, and their simplicity and ease of control, make them the machines *par excellence* for city work.

Actually, however, the electric automobile is still a luxury, the maintenance of which is more costly than that of a gasoline automobile. It can replace with advantage a two-horse equipage, and its annual cost of maintenance is comparable to that of the latter.

For trucking and other heavy work, electricity is to be recommended only when the routes to be habitually followed have but slight grades, and when the current

THE THURY 16-HORSEPOWER, FOUR-CYLINDER, GASOLINE-ELECTRIC AUTOMOBILE.

can be obtained at a very low price. As the cost of maintaining a battery of accumulators is estimated at from $200 to $240 a year, the total expense of operation will be too high if it is necessary to pay much for the electric energy. In cases where the annual cost does not enter into account, the employment of electricity as the motive power is ideal for trucks. While awaiting the day when accumulators shall fulfill the conditions just mentioned, the use of them in combination with a dynamo will be found of great advantage. Machines of this type are designated as "gasoline-electric" or "mixed" automobiles.

Among machines of this type, there is first the gasoline machine with electric transmission. This consists of a gasoline motor direct connected to a dynamo, which, alone or in combination with a battery of accumulators, supplies current to the electric motors that drive the rear wheels. If the comparison may be permitted, I will say freely that this is a Heilmann locomotive in miniature. I do not know if the reader will agree with me, but I fear that this type of automobile has not before it the future of the Heilmann locomotive. I already know of several firms, who built such machines, having abandoned them because of their low efficiency and great weight.

Great progress has lately been made, however, in the

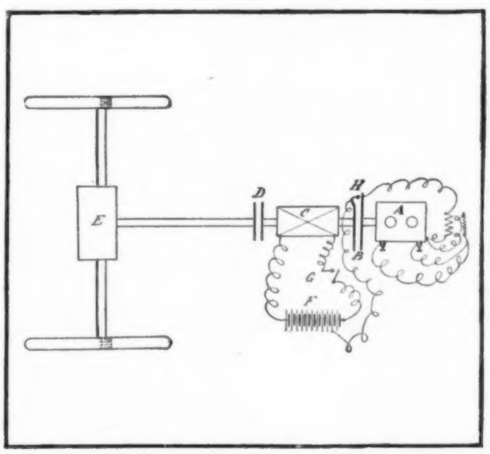


DIAGRAM SHOWING ARRANGEMENT OF MOTOR AND CLUTCHES ON THE THURY CAR.

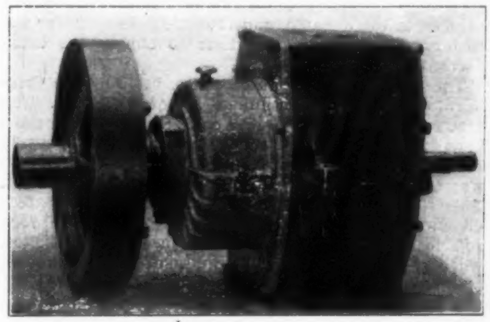
construction of gasoline-electric automobiles, by the Compagnie de l'Industrie Electrique et Mecanique, of Geneva, which has indirectly given to the explosive motor a flexibility that makes it almost faultless.

The diagram shows the principle of this interesting novelty.

The new machine is fitted with either a two or four-cylinder V motor, like that shown in one of our illustrations. The originality of the design consists in placing an electric dynamo, *C*, between the gasoline motor, *A*, and the differential gear, *E*. The usual friction clutch is placed at *D* between the dynamo and the rear axle, while at *B* there is another clutch like the first one. This permits of the coupling of the dynamo with the motor by means of a special pedal moving over a notched segment. When this clutch is thrown out, the ignition current of the motor is cut off at *H*.

The system is completed by a set of storage batteries, *F*, which is more or less powerful according to the service required of the vehicle. The present standard model carries about 330 pounds of batteries, which are connected to the dynamo through a switch, *G*, also operated by a pedal.

The dynamo is constructed with a view to producing a voltage equal to that of the battery when revolving at a speed slightly less than the normal speed of the

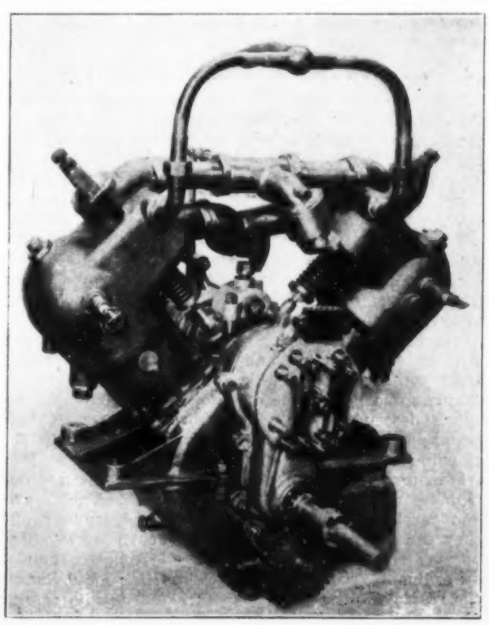


ELECTRIC MOTOR AND FRICTION CLUTCH ON THE THURY CAR.

gasoline motor, supposing the car to be running on a level. Let this speed, which will correspond to the ascent of a 3 to 5 per cent grade, be 1,000 revolutions per minute. When descending a similar grade, the normal speed will rise to 1,200 revolutions per minute, and the voltage of the dynamo becoming higher than that of the battery, the former will generate electricity and charge the latter. On the contrary, when ascending a 10 per cent grade, for example, the speed will fall to 800 revolutions per minute, the voltage of the dynamo will drop below that of the battery, and the latter will discharge into the former, which is now automatically changed into a motor that adds its power to that of the gasoline motor while the ascent of the hill is being made.

The electric system thus plays the role of a flywheel, but of a flywheel which has the immense advantage of conserving all its energy, even when the motor is stopped, and of proportioning exactly the energy which it returns to that which is absolutely necessary, whatever may be the speed. It permits of starting the gasoline motor automatically, as well as of running the vehicle by electricity alone for a few miles should the gasoline motor give out. It is, therefore, always possible in case of accident to reach a convenient stopping place, which is a great advantage.

The motors of the new machine are exceedingly strong, and any one can learn to operate them without special instruction. The rear wheels are driven by a universally-jointed driving shaft of a new type which



EIGHT-HORSEPOWER GASOLINE MOTOR OF THURY AUTOMOBILE.

drives through an intermediate pinion, and propels the vehicle very smoothly. In contradistinction to the usual bevel gear drive with live rear axle, this machine has a solid steel axle for supporting the body, while the drive to the wheels is quite independent of the axle, as when a chain drive from a countershaft is employed. The V motor used on this machine was chosen in order to diminish the length of the mechanical part of the car as much as possible. These

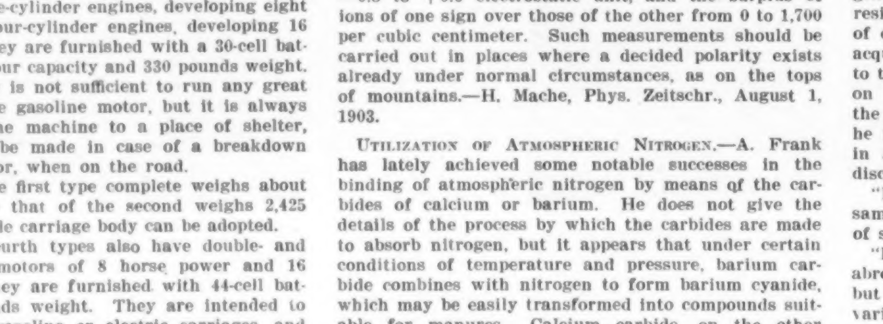
motors are very carefully constructed, and operate very regularly. The two-cylinder type is adapted to cars for town use, capable of a speed of from 17 to 18 miles an hour, while the four-cylinder type makes it possible to attain as high a speed as 30 miles an hour. Even more powerful motors can, of course, be used if desired.

The electric energy stored in the batteries furnishes current for a powerful electric headlight, as well as for an electric heater arranged in the floor. Other wires connected with the battery make it possible to heat water or prepare hot drinks while on the road. Finally, the electricity stored in the battery can be used for lighting a country house or driving farm machinery. A 330-pound set of batteries will generally furnish sufficient current to light fifty 10-candle power lamps for one hour or ten lamps for six hours. If more current is found necessary, the gasoline motor can be run coupled to the dynamo, and thus made to recharge the battery, and at the same time to supply the extra current.

The gasoline-electric automobiles, built by the Compagnie Electrique et Mecanique, are of four types. The first two have double-cylinder engines, developing eight horse power, and four-cylinder engines, developing 16 horse power, and they are furnished with a 30-cell battery of 30-ampere hour capacity and 330 pounds weight. This size of battery is not sufficient to run any great distance without the gasoline motor, but it is always sufficient to take the machine to a place of shelter, where repairs can be made in case of a breakdown of the gasoline motor, when on the road.

The chassis of the first type complete weighs about 1,984 pounds, while that of the second weighs 2,425 pounds. Any suitable carriage body can be adopted.

The third and fourth types also have double- and quadruple-cylinder motors of 8 horse power and 16 horse power, but they are furnished with 44-cell batteries of 1,100 pounds weight. They are intended to be used either as gasoline or electric carriages, and they have sufficient capacity to run twenty-five or thirty miles on the batteries alone. When so running, they have all the advantages of ordinary electric automobiles. The battery can be recharged by the gasoline



REAR AND FRONT SURFACE OF ELECTRICALLY-HEATED FOOTBOARD OF THE THURY AUTOMOBILE.

motor while the carriage is running or after it returns to its garage, or, if it is not desired to run the motor, it can be recharged from an outside source of current.

The third type is a vehicle for city use, the speed of which is limited to 12 or 15 miles an hour. As long as the batteries are charged, this speed remains nearly the same both on up and down grades. The weight of the complete chassis of this car is 2,865 pounds.

The fourth type is capable of speeds of 25 miles an hour. The accumulators and all the parts are, in all these types, mounted on the chassis, and the body is easily removed.

To sum up, therefore, the gasoline-electric automobiles in question can claim the following advantages: The automatic starting of the gasoline motor when turned over by the electric motor, thus doing away with the starting crank. The great flexibility of running, since the energy stored up in the battery permits of easy starting and keeps the gasoline motor from stalling on the hills. There is, therefore, no change-speed gear to be operated when climbing hills. When descending, an electric brake restores to the battery some of the energy lost during the ascent. The stopping and starting of the gasoline and of the electric motor are accomplished at will while the machine is under way by means of a simple pedal. The electric and gasoline motors are completely independent, and they can drive the vehicle independently or together, as may be wished. The efficiency is equal to that of an ordinary gasoline car, as the gasoline motor drives the rear axle directly without transforming its energy. In case the gasoline motor breaks down, the car can run several miles on the energy stored in the accumulators, and there is, consequently, nothing to fear from breakdowns on the road. The lighting and heating are done by electricity. The ignition batteries are always charged. Finally, if it is desired, the owner of the vehicle can light his house and his garage with the energy stored up while running on the road. The machines which we have just described are, therefore, exceedingly comfortable touring cars. While waiting for something better, the solution of the problem which we have just described is at once the most economical, ingenious, and practical one that has as yet been invented and put into operation.

CONTEMPORARY ELECTRICAL SCIENCE.*

ELECTRIC DISSIPATION DURING THUNDERSTORMS.—H. Mache has devised a quick method of measuring electric dissipation, which gives the surplus of ions of one sign over those of the opposite sign almost instantaneously, instead of taking about a quarter of an hour, like the usual method. A radium electrode is suspended in a wire cage and connected with an electroscope through an iron tube, both the latter and the cage being earthed. In fine weather the electrometer shows only slight variations of potential not exceeding 1 volt. But it shows lively oscillations when thunderstorms are raging, even when the air potential itself is pretty constant. This is not surprising, since the indications of the cage electrometer only depend upon the ionic surplus, whereas the external field is governed by four elements, viz., the charges of the earth and the clouds, the charge on the precipitation, and the free ionic electricity. To give an approximate quantitative measurement, the author estimates that during a short thunderstorm the charge per cubic meter varied from −0.8 to +0.6 electrostatic unit, and the surplus of ions of one sign over those of the other from 0 to 1,700 per cubic centimeter. Such measurements should be carried out in places where a decided polarity exists already under normal circumstances, as on the tops of mountains.—H. Mache, Phys. Zeitschr., August 1, 1903.

UTILIZATION OF ATMOSPHERIC NITROGEN.—A. Frank has lately achieved some notable successes in the binding of atmospheric nitrogen by means of the carbides of calcium or barium. He does not give the details of the process by which the carbides are made to absorb nitrogen, but it appears that under certain conditions of temperature and pressure, barium carbide combines with nitrogen to form barium cyanide, which may be easily transformed into compounds suitable for manures. Calcium carbide, on the other hand, does not form calcium cyanide, but calcium cyanamide, with liberation of carbon, thus:

$$CaC_2 + 2N = CaCN_2 + C.$$

This body might be converted into cyanide, but it is more profitable to convert it into ammonia or its compounds by heating it with water under high pressure:

$$CaCN_2 + 3H_2O = CaCO_3 + 2NH_3,$$

or from the pure cyanamide:

$$CN_2H_2 + 3H_2O = 2(NH_4)CO_3.$$

But the calcium cyanamide may even be used directly as a manure, the necessary chemical transformations being accomplished naturally in the soil. Experiments have shown that its effects are only slightly inferior to those of Chili saltpeter. Its percentage of nitrogen is between 14 and 23, and thus is comparable with that of niter.—A. Frank, Intern. Congress of Applied Chemistry, Berlin, June 3, 1903.

ELECTRIC DICHROISM OF LIQUIDS.—After Meslin's work on the modifications undergone by a beam of natural light in traversing liquids containing crystalline particles in suspension and placed in a magnetic or electric field, J. Chaudier has proceeded to study the behavior of a number of such liquids, with a view to deducing the laws governing this magnetic and electric dichroism. He uses a glass trough placed on ebonite and flanked by two metallic plates forming the electrodes. A beam of light was transmitted through the liquid parallel to the electrodes, and analyzed by a Soleil bi-quartz polariscope. The natural dichroism of the substances, if any, was first measured, and then the difference of potential was applied. The liquids studied included carbon bisulphide, benzine, amylene and chloroform, and the crystalline substances gallic, pyrogallic, boric and picric acids, helianthine, sodium bicarbonate and some benzoates and citrates. The effect depends apparently upon the physical rather than the chemical character of the substances, and appears and disappears gradually, thereby differing clearly from the Kerr effect, which is instantaneous. For the same solid the dichroism may be either positive or negative, according to the liquid in which it is suspended. The magnetic dichroism may be, for the same substances, of a different sign from the electric dichroism. Generally speaking, the beam emerging from the magnetic field is plane-polarized, whereas the beam is elliptically polarized by the electric field.—J. Chaudier, Comptes Rendus, July 27, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

[Concluded from SUPPLEMENT No. 1466, page 23495.]

JAMES SMITHSON.*

By SAMUEL PIERPONT LANGLEY.

THE President of the Royal Society, in a necrology for the year 1829, associated the name of Smithson with those of Wollaston, Young, and Davy, saying that "he was distinguished by the intimate friendship of Mr. Cavendish, and rivaled our most expert chemists in elegant analyses;" while at an annual meeting of the Royal Society held on November 30, 1830, the president, Davies Gilbert, after referring to other members recently deceased, said:

"The only remaining individual who has taken a direct and active part in our labors, by contributing to the 'Transactions,' is Mr. James Lewis Smithson, and of this gentleman I must be allowed to speak with affection. We were at Oxford together, of the same college, and our acquaintance continued to the time of his decease.

"Mr. Smithson, then called Macie, and an undergraduate, had the reputation of excelling all other resident members of the university in the knowledge of chemistry. He was early honored by an intimate acquaintance with Mr. Cavendish; he was admitted to the Royal Society, and soon after presented a paper on the very curious concretion frequently found in the hollow of bambû canes, named Tabasheer. This he found to consist almost entirely of silex, existing in a manner similar to what Davy long afterward discovered in the epidermis of reeds and grasses.

"He was the friend of Dr. Wollaston, and at the same time his rival in the manipulation and analysis of small quantities. Ἀγαθὴ δ' ἔρις ἥδε βροτοῖσι.

"For many years past Mr. Smithson has resided abroad, principally, I believe, on account of his health; but he carried with him the esteem and regard of various private friends, and of a still larger number of persons who appreciated and admired his acquirements."

His writings exhibit clearness of perception, terseness of language, and accuracy of expression. He was an intimate friend of Cavendish, and later of Arago; he was a correspondent of Black, of Banks, of Thomson, and of most of the names then renowned to science, and he himself contributed in those early days honorably to the enlargement of those "lucid specks in the vast field of darkness," of which he spoke, toward the coming light.

His industry was the more creditable to him in that he was at this time a man of large means, with every temptation to devote himself to amusement, and this industry will be seen to be still greater when it is remembered that these published papers are but a small portion of his writings; for 200 manuscripts were forwarded to the United States with his effects, and, besides these, thousands of detached notes and memoranda.

Unhappily, with the exception of one small volume, of all these nothing remains, the whole of the originals having been destroyed in the disastrous fire at the Institution in 1865, just one hundred years from the date of his birth. We know something of these manuscripts from the paper by Mr. Johnson, who had access to them before the formation of the Institution, and from it we learn that they are connected not only with science, but with history, the arts, language, rural pursuits, gardening, the construction of buildings, and kindred topics, "such as are likely to occupy the thoughts and to constitute the reading of a gentleman of extensive acquirements and liberal views derived from a long and intimate acquaintance with the world," while his cabinet, which was also destroyed by the fire, is described as consisting of a choice collection of minerals, comprising probably eight or ten thousand specimens, in exceedingly perfect condition, including examples of most of the meteorites which had fallen in Europe during several centuries, and forming what was at the time very much the richest and rarest collection in the United States.

If, then, we ask whether Smithson had such a competent scientific knowledge as would enable him to use with deliberate choice the language of his will, we may answer with confidence that his was the knowledge of a professional student, and not of the amateur, that he was one who could well discriminate between what was best for the increase and what was best for the diffusion of knowledge, and that the capacity for terse expression already referred to shows itself eminently in the concision and clearness with which he expresses this distinction, in that most brief and most important of clauses of his will presently to be cited.

We have a likeness of him taken in the form of a bust, executed probably in the years when he was most active in these scientific labors. The precise date of the bust (a reproduction of which on steel by Charles Burt was made in 1879) is unknown.

Of Smithson's subsequent life we know but little. His later years appear to have been tried by bad health and painful infirmities. During these years he seems to have resided chiefly in Paris, where he lived at No. 121 Rue Montmartre, and where he was in the habit of entertaining his friends. One gathers from his letters, from the uniform consideration with which he speaks of others, from kind traits which he showed, and from the general tenor of what is not here particularly cited, the impression of an

* Reprinted from "The Smithsonian Institution, 1846-1896. The History of its First Half Century." Edited by G. Brown Goode.

innately gentle nature, but also of a man who is gradually renouncing, not without bitterness, the youthful hope of fame, and, as health and hope diminish together, is finally living for the day rather than for any future.

To this period belongs an interesting citation from Arago's eulogy on Ampère:

"Some years since in Paris I made the acquaintance of a distinguished foreigner, of great wealth, but in wretched health, whose life, save a few hours given to repose, was regularly divided between the most interesting scientific researches and gaming. It was a source of great regret to me that this learned experimentalist should devote the half of so valuable a life to a course so little in harmony with an intellect whose wonderful powers called forth the admiration of the world around him. Unfortunately there occurred fluctuations of loss and gain, momentarily balancing each other, which led him to conclude that the advantages enjoyed by the bank were neither so assured nor considerable as to preclude his winning largely through a run of luck. The analytical formulas of probabilities offering a radical means, the only one perhaps of dissipating this illusion, I proposed, the number of games and the stakes being given, to determine in advance, in my study, the amount, not merely of the loss of a day, nor that of a week, but of each quarter. The calculation was found so regularly to agree with the corresponding diminution of the bank notes in the foreigner's pocketbook that a doubt could no longer be entertained."

I owe to Dr. B. A. Gould the interesting statement that Arago was not merely an acquaintance, but an intimate friend of Smithson, and that Arago personally told him that "the distinguished foreigner" in question was Smithson himself, and added that Smithson resolved, not to absolutely discontinue play (in which he found the only stimulus which could make him forget his physical suffering), but to do so with a care that the expenditure for this purpose was a definite one, and within his means.

We see him next entering the confines of old age, approaching the task (with such enfeebled health, a solemn one) of making his last will, and looking back upon a life which his circumstances have made lonely, which has been uncheered by domestic affection, and which, though filled with honorable activities, has not brought the fame to which he once aspired with the hope that it would bring some compensation for the accident of birth.

The most important act of his life was the execution of this will, a copy of which follows:

THE WILL OF JAMES SMITHSON.

"I James Smithson Son to Hugh, first Duke of Northumberland, & Elizabeth, Heiress of the Hungerfords of Studley, & Niece to Charles the proud Duke of Somerset, now residing in Bentinck Street, Cavendish Square, do this twenty-third day of October, one thousand eight hundred and twenty-six, make this my last Will and Testament:

"I bequeath the whole of my property of every nature & kind soever to my bankers, Messrs. Drummonds of Charing Cross, in trust, to be disposed of in the following manner, and I desire of my said Executors to put my property under the management of the Court of Chancery.

"To John Fitall, formerly my Servant, but now employed in the London Docks, and residing at No. 27 Jubilee Place, North Mile end, old town, in consideration of his attachment & fidelity to me, & the long & great care he has taken of my effects, & my having done but very little for him, I give and bequeath the Annuity or annual sum of One hundred pounds sterling for his life, to be paid to him quarterly, free of legacy duty & all other deductions, the first payment to be made to him at the expiration of three months after my death. I have at divers times lent sums of money to Henry Honore Sailly, formerly my Servant, but now keeping the Hungerford Hotel, in the rue Caumartin at Paris, & for which sums of money I have undated bills or bonds signed by him. Now, I will & direct that if he desires it, these sums of money be let remain in his hands at an Interest of five per cent for five years after the date of the present Will.

"To Henry James Hungerford, my Nephew, heretofore called Henry James Dickinson, son of my late brother, Lieutenant-Colonel Henry Louis Dickinson, now residing with Mr. Auboin, at Bourg la Reine, near Paris, I give and bequeath for his life the whole of the income arising from my property of every nature & kind whatever, after the payment of the above Annuity, & after the death of John Fitall, that Annuity likewise, the payments to be made to him at the time of the interest or dividends becomes due on the Stocks or other property from which the income arises.

"Should the said Henry James Hungerford have a child or children, legitimate or illegitimate, I leave to such child or children, his or their heirs, executors, & assigns, after the death of his, or her, or their Father, the whole of my property of every kind absolutely & forever, to be divided between them, if there is more than one, in the manner their father shall judge proper, or, in case of his omitting to decide this, as the Lord Chancellor shall judge proper.

"Should my said Nephew, Henry James Hungerford, marry, I empower him to make a jointure.

"In the case of the death of my said Nephew without leaving a child or children, or the death of the child or children he may have had under the age of twenty-one years or intestate, I then bequeath the whole of my property, subject to the Annuity of One hundred pounds to John Fitall, & for the security & payment of which I mean Stock to remain in this Country, to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an Establishment for the increase & diffusion of knowledge among men.

"I think it proper here to state, that all the money which will be standing in the French five per cents at my death in the names of the father of my abovementioned Nephew, Henry James Hungerford, & all that in my names, is the property of my said Nephew, being what he inherited from his father, or what I have laid up for him from the savings upon his income.

JAMES SMITHSON. [L. S.]"

We see that he begins by recalling the parentage which had denied him the name of his father and the position in the world he believed should have been his, and, in the void places of father, brother, or family, he seems to look for some object of affection, and to find only an old servant (whom he remembers with thoughtful liberality) and a nephew, to whom he bequeaths his property. He has provided for the continuance of the property to any possible heir to this nephew, and there seems to remain nothing more.

But there must have remained, in the retrospect of such a life as his, a sense of failure of that purpose with which he entered it, when he hoped, with youthful ambition, to create a greater name than that which birth had denied him, and when he wrote, "My name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten," and there must have come up on such an occasion the question whether this was, indeed, the end of hope and the time only for renunciation.

We see that he has not utterly renounced this hope even now; but it is so faint that he writes between a clause which concerns a legacy of a servant and one which concerns an investment in the funds, and, as it were, almost casually, the words which have perpetuated his name.

Probably no man ever made a more remunerative investment in the direction in which he would like best

JAMES SMITHSON, FOUNDER OF THE SMITHSONIAN INSTITUTION.

to see a return than was brought out by these words of Smithson, for we now all know that his bequest, when accepted by the United States government, formed the initial step in the creation of an institution whose position has been altogether exceptional, for it is likely to remain without successor, as without precedent, in perpetuating, as it does, the fame of a private individual, whose wishes have been adopted and carried into effect by a great nation, which has consented to take the position of a guardian to a ward in the care of his property, and which has subsequently made his private fortune the nucleus to which have been added appropriations for objects of national importance, yet appropriations which are still administered in association with his name.

The will was proved in the Prerogative Court of Canterbury, the value of the effects being sworn to be under £120,000. The property disposed of by it is believed to have been received chiefly from Col. Henry Louis Dickinson, a son of his mother by a former marriage, though he is known to have received a legacy of £3,000 from Dorothy Percy, his half-sister on his father's side; but, unless through this, it is proper to state that there is no indication that any portion whatever of the Smithson bequest was derived from the Northumberland family.

The motives which actuated Smithson in mentioning the United States as his residuary legatee, rather than any other government or institution, must remain in doubt, for he is not known to have had any correspondent in America, nor are there in any of his papers any reference to it or its distinguished men. In selecting the nation itself as the depository of his trust, he yet certainly testified his confidence in its institutions and his faith in their perpetuity, while it has not escaped attention that he uses language in the determining clause of his will remarkably similar to that already employed by Washington, who in his farewell address, says: "Promote, as an object of primary importance, institutions for the general diffusion of knowledge."

Smithson died June 27, 1829, at Genoa, Italy. He is buried in the little English cemetery on the heights of San Benigno, in a tomb which originally bore no reference to him as the founder of this Institution; but the Institution has recently placed a tablet there remedying this omission, has surrounded the tomb with evidence of continued care, and has placed in still further remembrance a similar tablet in the English church of the city.

Smithson's wishes have been carried out by those immediately administering them with a constant scrupulous thought of the intent of the founder, while in doing this the best results have flowed from a rigid construction of his own words, so briefly expressed, and from a division of the activities of the Institution into two great distinct but parallel paths, the "increase" and "diffusion" of knowledge.

What has been done in these two paths the reader may partly gather from this volume—in the former, from the various articles by contemporary men of science, describing its activities in research and original contributions to the increase of human knowledge; in the latter, in numerous ways—among others, from the description of the work of one of its bureaux, that of the International Exchanges, where it may be more immediately seen how universal is the scope of the action of the Institution, which, in accordance with its motto, PER ORBEM, is not limited to the country of its adoption, but belongs to the world, there being outside of the United States, at the time I write, more than 12,000 correspondents, scattered through every portion of the globe; indeed, there is hardly a language or a people where the results of Smithson's benefaction are not known and associated with his name.

If we were permitted to think of him as conscious of what has been, is being, and is still to be done, in pursuance of his wish, we might believe that he would feel that his hope, at a time when life must have seemed so hopeless, was finding full fruition; for events are justifying what may have seemed at the time but a rhetorical expression, in the language of a former President of the United States, who has said, "Renowned as is the name of Percy in the historical annals of England, . . . let the trust of James Smithson to the United States of America be faithfully executed, . . . let the result accomplish its object, the increase and diffusion of knowledge among men, and a wreath more unfading shall entwine itself, in the lapse of future ages, around the name of Smithson than the united hands of history and poetry have braided around the name of Percy through the long ages past."

The principal sources of information for this chapter have been as follows:

1. Gentlemen's Magazine for March, 1830, page 275.

2. The documentary evidence which, though meager, may be found in the report of Richard Rush to the Department of State, in 1838.

3. The manuscripts and diary of Smithson, which are described as comprising about two hundred titles, besides the numberless notes of an encyclopædical character, "such as are likely to occupy the thoughts of a gentleman of extensive acquirements and liberal views." These manuscripts were destroyed by the fire of 1865, but not until extended extracts had been made from them by Walter R. Johnson, a member of the National Institute of Washington, in whose possession the papers and books of Smithson remained until the formation of the Institution. The paper by Johnson will be found in Volume xxi of the "Smithsonian Miscellaneous Collections," and these lost papers are the original sources of some statements made here which can no longer be verified by comparison with the originals.

4. These sources are not only contained in, but are largely supplemented by, the excellent memoir on

"James Smithson and his Bequest," by Mr. William J. Rhees, forming part of Volume xxi of the "Smithsonian Miscellaneous Collections," without which the biography of Smithson can hardly be written, and from which the writer has here frequently quoted textually, without other acknowledgment than this general and explicit one.

5. Another source of information is the researches made by the writer with the aid of Dr. Cyrus Adler, Librarian of the Smithsonian Institution, in England, in 1894.

SOLVENT PROCESS FOR DEGREASING WOOL.

The solvent process employed for degreasing wool consists essentially of treating the wool, in closed digesters, with volatile solvents—like benzine, petroleum spirit, carbon bisulphide, or carbon tetrachloride—until a complete extraction is effected. One of the principal features of a new solvent process is the employment of compressed gas as a forcing or motive power to circulate the solvent through the wool under treatment. It is used to press the liquid solvent out of the wool as well as to blow out of it such solvent as has not been removed by pressure. It is also used as a heat-carrying medium to the wool, and as a carrying medium for the solvent vapor from the wool. It is furthermore used as an atmosphere wherein to carry on the extracting operation, both for covering the solvents in the reservoirs and for taking the place of the solvent removed from any part of the apparatus.

Fig. 1.—TUBERCLES OF VELVET BEAN PRODUCED BY INOCULATION.

[Natural size.]

Fig. 2.—COMPARISON OF VETCH PLANTS GROWN UPON INOCULATED AND UNINOCULATED SOIL.

[Reduced about one-third.]

This prevents the ignition of the solvent vapor by any spark which might accidentally be communicated to it, and since the gas is always moved in a closed circuit it prevents the loss of solvent vapors and can be used repeatedly without limit.

The saving effected by the "solvent process" to establishments that degrease and work their own wool for worsted purposes can be expressed in round numbers as averaging one penny per pound, figuring on the greasy wool. This saving is made in the cost of the soap, which is entirely dispensed with by the new process; in a greater yield of the wool fibers, since none of it is dissolved by soap and alkali; in a larger proportion of top to noil, because the wool, being free from any felted parts, cards and combs freely without breaking the fibers or the making of nibs; in a larger production of the cards, combs, and drawing and spinning machinery; in the superior softness and appearance of the finished product; in the wool fat removed; and in the potash recovered. The cost of the degreasing operation, including labor, solvent, power, interest, depreciation, etc., is, it is estimated, more than covered by the soap saved.

Openings for American Rubber Shoes in France.—It seems to me that skeleton gum shoes and rubber overshoes would meet with a ready sale anywhere in northern and western France, where the climate is such as to compel the almost constant use of footwear of that character, and I think it would be well worth the while of any of our manufacturers in this line to send their representatives to Nantes.—Benj. H. Ridgely, Nantes, France.

BACTERIA AND THE NITROGEN PROBLEM.*

By George T. Moore, Physiologist in Charge of Laboratory of Plant Physiology, Bureau of Plant Industry.

INTRODUCTION.

There is probably no fact in plant physiology which has been more firmly established than that all plants must have nitrogen in order to thrive, and that under normal conditions this nitrogen must be obtained through the roots in some highly organized form. It is not necessary to discuss this point, for practical experience demonstrates its truth every time a soil is exhausted by any crop, and the farmer testifies to his belief in this fact when he tries to re-establish the fertility of his ground by adding some fertilizer rich in nitrogenous matter. While there are certain other substances, such as phosphoric acid, potash, iron, etc., which plants must have and can only obtain through the soil, the demand for nitrogen is so much greater and in one sense so much more important, that the question of the available nitrogen supply in the world has come to be looked upon as lying at the very foundation of agriculture and demanding the most careful consideration. Since the conditions of life in the civilized quarters of the globe are such as to cause a constant loss of nitrogen, there have been some who have predicted what has been termed a "nitrogen famine," which is to occur within the next forty or fifty years, and the possibility of such a catastrophe has been very graphically portrayed. On the other hand, there are investigators who feel that the possibility of such a condition has been much exaggerated and that the amount of nitrogen in the soil can never be exhausted to such an extent as to affect the crop-producing power of the earth. In order that we may be able to form a more definite opinion upon the subject, it may be well to look at some of the ways in which nitrogen is lost, and then see how it may be reclaimed.

How Nitrogen is Lost.

In the first place, the conditions of life on the ordinary farm are such as to cause the constant loss of this valuable element through the removal of the crops taken from the soil. If every crop that grew on the land could be returned to it, nature has made provision for getting it back in suitable form for plant food. In the case of nitrogen, neither plants nor animals are able to produce this substance directly in an available form. It is necessary that certain bacteria take hold of plant and animal products, and by means of peculiar changes produce nitrates from their fats, sugars, starches, etc. Without these bacteria everything would have come to a standstill long ago, for unless decay takes place and the decomposed elements are rearranged into definite nitrogenous salts no plant is able to use them. Thus, it will be seen that certain bacteria in the soil play as important a part in the food supply of the earth as do the animals and larger plants upon which we think we are so dependent.

It is hardly necessary to refer to the vast waste of nitrogenous material that is involved in modern sewage methods. Millions of dollars' worth of nitrogen which would naturally return to the soil under the action of nitrifying bacteria is every year carried off in various waterways and ultimately reaches the ocean, where, of course, it is of no benefit to man. More than fifty years ago Liebig said on this subject:

"Nothing will more certainly consummate the ruin of England than the scarcity of fertilizers. It means the scarcity of food. It is impossible that such a sinful violation of the divine laws of nature should forever remain unpunished, and the time will probably come for England, sooner than for any other country, when with all of her wealth in gold, iron, and coal she will be unable to buy the one-thousandth part of the food which she has during hundreds of years thrown recklessly away."

A third great source of nitrogen loss is through the action of a group of bacteria which have the power of breaking down nitrates, depriving them of oxygen, and reducing them to ammonia or nitrogen gas, when they are, of course, unavailable for plant food. This process of denitrification, while very useful in the septic tank, which is the most sanitary method of sewage disposal, is the source of considerable loss to the farmer, and manures may often be rendered practically worthless by the action of these bacteria.

Other means by which nitrogen is lost so far as plant foods are concerned, are the washing out of nitrogen salts from the soil and the burning of explosives which are largely composed of some nitric salt that would be directly valuable to the vegetable kingdom. The action of nitrate of soda, or saltpeter, has been studied experimentally, and it is known that up to a certain maximum about 23 pounds of nitrate of soda will yield an increase of 1 bushel of wheat per acre. Thus, when hundreds of thousands of tons of explosives are used in waging war, every battle liberating nitrogen which, if applied to the soil, would increase the yield of wheat by thousands of bushels, the actual cost of war should be estimated at considerably more than is usually calculated; and if there is soon to be a nitrogen famine, war becomes more serious than ever before.

With all of these destructive forces at work and nitrogen being liberated on every hand, it is no wonder that thinking men have become alarmed at the prospect, and have endeavored in every way possible to

* From Year Book of Department of Agriculture.

discover some means of increasing the world's supply of this most necessary element.

HOW NITROGEN IS GAINED.

The most valuable compound containing sufficient fixed nitrogen to be used in any quantity as a nitrogenous fertilizer is the nitrate of soda, already referred to as the basis of so many explosives. This salt occurs naturally in certain regions of Chile and Peru, where for countless centuries the continuous fixation of atmospheric nitrogen has been carried on by bacteria. Unfortunately, however, like any other mineral supply in the earth, the quantity is limited, and although it is difficult to get accurate estimates of the amount of nitrate remaining in the beds, authorities seem to agree that at the present rate of export the raw material will all be exhausted within from forty to fifty years. To show how much more rapidly this supply is being exhausted than was thought possible forty years ago, it is only necessary to state that in 1860 all estimates showed that the amount of nitrate of soda then known would last for nearly fifteen hundred years. The demand has rapidly increased, however, and although the output is controlled, there is annually consumed in the world's markets nearly 1½ million tons of nitrate of soda, representing a value of about $100,000,000. Of this amount, the United States requires about 15 per cent, and it is by far the most expensive fertilizer that is in use by the farmer.

In addition to the nitrate of soda beds there have also been large deposits of guano, which have served as one of the principal sources of nitrogen. The greater part of the guano beds are now completely exhausted, however, and although new deposits are occasionally discovered, they are of such limited area, or of such a low percentage of nitrogen, as to have practically no effect upon the available nitrate supply.

There are certain other chemical salts which furnish a limited amount of nitrogen, such as the product which remains from the distillation of coal in the process of gas making, but all of them are obtained in such comparatively small quantities that they are not worth taking into consideration when one realizes the enormous amount of nitrogenous fertilizer necessary to replace the combined nitrogen which is annually removed from the soil in one way or another.

Ever since the importance of increasing the combined nitrogen supply has been realized, men of science have naturally turned to the atmosphere as being the most promising field for experiment and the one most likely to eventually solve the whole problem. When it is remembered that nearly eight-tenths of the air about us is nitrogen, and that plants are able to obtain their entire source of carbon from a gas which is present in the comparatively small proportion of one-tenth of 1 per cent, it seems almost incredible that there should be any more difficulty about a plant's nitrogenous food than about its supply of carbon dioxid. Since it seemed so well settled, however, that plants could not use nitrogen as a gas, the chemists and physicists have made every effort to devise some mechanical means of making this element available in a combined form. It has been known that discharges of lightning passing through the air are able to fix free nitrogen, and, beginning with this as a basis, some very satisfactory results have been obtained by the use of electricity. With a power sufficiently cheap and with perfect machinery, there seems good reason to believe that in the near future it will be possible to place upon the market a manufactured nitrate of soda or nitrate of potash that will be superior in quality to the deposits found in South America, and that will also be reasonable enough in price to compete with the natural product.

NITROGEN-FIXING BACTERIA.

Fortunately, there are still other means by which nitrogen gas may be made available for plant food, and that, too, without requiring the introduction of a commercial product, which must always be rather expensive, whatever degree of perfection may be reached in the mechanical operation of the process. Ever since the earliest days of agricultural science it has been noticed that certain land, if allowed to stand fallow for a considerable length of time, would gain in nitrates without any visible addition having been made. It is now known that one of the principal means of this increase in nitrogen content is due to a few forms of soil bacteria which have the power of fixing the free nitrogen from the air and rendering it available for plant food. These organisms have been isolated and cultivated artificially, and great hopes were held at one time that it would be possible to inoculate land with these cultures and thus bring about a large increase in the nitrogenous salts without the aid of any manure or mineral fertilizer. Under certain conditions these bacteria seemed able to do a large amount of work, and there are experiments on record where the crops raised from plots inoculated with nitrogen-fixing organisms were much greater than crops from uninoculated land. Unfortunately, these results were not always constant, and such a large percentage of failures had to be reported that from a practical standpoint the use of such cultures is now considered worthless. A matter of such vast importance to agriculture, however, should not be neglected simply because of first failures. It is quite possible that as we becom better acquainted with the habits of these bacteria and learn the conditions which are most favorable to fixing nitrogen and the causes which prevent this operation from going on at all times, we shall be able to discover some means of using these nitrogen gatherers in practical farming.

FIG. 3.—VETCH FIELD, SHOWING EFFECT OF INOCULATION.

[Uninoculated plat at left; inoculated plat at right.]

Root Tubercle Bacteria.

In the meantime there is still one other means at hand which can be used and has been used for countless centuries as a most efficient method of conserving the world's nitrogen supply. Ever since the time of Pliny and other early writers upon agricultural topics, it has been known that certain leguminous crops, such as clover, beans, peas, etc., did not require the same amount of fertilizer as other plants, and indeed it seemed as though they actually benefited the soil instead of being a detriment. Various theories have been advanced to account for this effect, perhaps the most widespread opinion being that members of this family, owing to the unusual length and strength of their root system, were able to draw upon a store of food that was not available to wheat and corn and other crops not belonging to the pod-bearing group. It is only within a comparatively recent time that the real cause of the beneficial effect of these legumes has been fully understood, and it seems that here again the bacteria are responsible for the nitrogen-gathering power; for it is because these plants are able to fix and use the free nitrogen of the air that they are of such benefit in rotation and in reviving poor and exhausted land. The immense yields of wheat following alfalfa or clover are easily understood when it is realized that there has actually been added to the soil a certain definite amount of nitrogen in such form that the wheat can be benefited by it. Such efficient users of the atmospheric nitrogen are clover and peas and similar crops that they can actually live and thrive in a soil that has not the first trace of combined nitrogen within it. If quartz sand be ignited to red heat, thus burning out all the nitrates, and then be planted with peas or beans, it is possible to bring these plants to full maturity without in any way allowing a particle of fixed nitrogen to find its way into the soil. On the other hand, wheat or potatoes, or crops not legumes, will die as soon as the small amount of nitrogen available from the seed is exhausted. What is the reason for this? It can not be merely a difference in the length or extent of the root system, because plants flourish where it is certain there are no available nitrates whatever. For a long time the presence of certain peculiar nodules or tubercles upon the legumes has been noted and speculated upon. These formations are always present upon the roots of leguminous plants grown under proper conditions, and may vary in size from that of the smallest pin head, in some clovers, to a cluster as large as a potato, as shown in Fig. 1, a natural-sized view of the inoculated roots of a velvet bean plant. They have been thought to be due to the bites of worms and insects, or to be caused by conditions of the soil and various abnormal climatic effects, and only within very recent years has it been learned that these formations are due to the presence of innumerable bacteria, and that unless these tubercle-producing bacteria exist the plant is no more able to use the nitrogen from the air than wheat or any of the other crops which do not have such nodules on their roots.

MICROSCOPIC APPEARANCE OF TUBERCLES.

If a thin cross sect on of one of these tubercles be examined under the microscope it will be seen that the cells are very much larger than in a normal root, and that almost the entire contents have been replaced by masses of minute bacteria. These bacteria gain an entrance into the plant through the root hairs, and may assume shapes very different from the ordinary rods and spheres that are usually found in this group. The appearance of branching forms has led some observers

FIG. 4.—ROOTS OF SOY BEAN GROWN IN SOIL INOCULATED WITH ORGANISMS FROM RICH NITROGENOUS MEDIA.

FIG. 5.—ROOTS OF SOY BEAN GROWN IN SOIL INOCULATED WITH ORGANISMS FROM NITROGEN-FREE MEDIA.

[Both figures reduced one-third.]

to consider that these tubercle formers were not true bacteria, but belonged to some group intermediate between the bacteria and fungi. This is not probable, however, for there is abundant evidence to prove their relationship to the true bacteria, and while the peculiar shapes are somewhat characteristic of the group, they are not exclusively of this form, many tubercles having nothing but the short rods.

Just where the nitrogen is fixed and how it is used by the plant have been debated questions. Some have supposed that the presence of the bacteria in the roots simply acted as a stimulus, and that the leaves of the plant were thus able to take in nitrogen as a gas and to elaborate nitrates from it in some such way as carbon is formed from carbon dioxid. It seems much more probable, however, that the bacteria themselves fix the nitrogen in the roots of the plant and that it is then used as nitrates would be used from the soil. It is certain that these tubercle organisms can fix free nitrogen in cultures, and there is no reason to suppose that this power is lost when within the roots of a legume. Furthermore, it seems as though the plant actually uses the contents of these tubercles, for at the end of the season the tubercles are found to be much softer and shrunken, and are practically emptied of their mass of bacteria.

Effect of Tubercles.

The effect of the presence of tubercles upon vetch may be seen from Fig. 2, where two plants, one with and one without tubercles, are shown. This is a very poor example, however, of the benefit of these tubercles to a whole crop. While it is difficult to show in a photograph a field that will bring out the advantage of the presence of the nitrogen-fixing bacteria, perhaps Fig. 3 will illustrate this difference in a general way. It is a well-established fact, and has been shown by a number of independent investigators in various parts of the country, that the leguminous crop which bears tubercles will exceed a similar crop without tubercles by from 100 to 1,000 per cent; that is, a field of clover grown on such poor soil that it would only yield 200 pounds to the acre would be so invigorated by the presence of tubercle-forming bacteria that on exactly similar soil it would produce from 400 to 2,000 pounds to the acre, and this without any cost whatever for fertilizers and with very little more labor. In addition to the increase of the actual weight of the crop, tubercles also cause the plants to flower and fruit earlier, and the number of seed produced is very much greater.

Thus it will be seen that it is worse than useless to attempt to grow any leguminous crop without being certain of the presence of the bacteria which enable the plant to fix free nitrogen. It would be much better to fertilize heavily and attempt to raise some more profitable crop than to introduce clover or beans or some other legume for the purpose of enriching the soil. It cannot be too strongly emphasized that unless the tubercles are present the leguminous crop is of absolutely no more benefit to a soil than wheat or potatoes.

While these organisms are pretty generally distributed throughout the earth, and it is quite possible in many parts of the country to grow almost any leguminous crop and secure these tubercles, it is also true that certain regions are practically devoid of the right kind of bacteria, and that unless some artificial means of introducing the germs be resorted to the crop will be a failure.

Artificial Inoculation of the Soil.

In the past there have been two methods used in attempting to bring about artificial inoculation. Naturally where a certain leguminous crop has been grown successfully for a number of years the soil will become filled with tubercle organisms, and by transporting this earth to new fields the organisms will thus become available for forming the nodules in localities where they previously had not existed. This was the means by which the soy-bean organisms were brought from Japan, and there are very few places in this country where soy is now grown that did not receive their inoculation, indirectly at least, from the Japanese soil.

There are two serious objections to soil inoculations, however. One is the expense, for it requires anywhere from 500 to 1,500 pounds of earth per acre to produce a satisfactory growth of tubercles, and if this has to be transported for a large farm, the cost is almost prohibitive. There is still another and more serious objection, however, and that is the danger of transmitting plant diseases by this method. Several of the more serious diseases which attack crops are readily conveyed in the soil, and there are numerous cases on record where diseases of leguminous and other crops have been introduced into regions previously entirely free from them through an effort to bring about a soil inoculation of the tubercle-forming organism. Consequently, if any safer and cheaper method could be devised for making these germs available, it would be most desirable.

A few years ago certain German investigators put upon the market a product known as nitragin, which purported to be a pure culture of the root-tubercle organism. These cultures were only adapted to specific crops, for it has been held that each kind of leguminous plant had a special germ better adapted to produce tubercles upon it than any other form, and for this reason it was necessary to use one organism for clover, another for peas, and so on. This preparation, nitragin, has been used with varying success abroad. Some experiments seemed to show that it was of the greatest value, while others were complete failures in demonstrating its worth. The failures so far outnumbered the successes, however, that its manufacture has been abandoned, and it can no longer be obtained. A few attempts have been made to use these cultures in this country, and while some very satisfactory results were obtained, the number of failures was even greater than abroad, the varying conditions involved in transportation and the length of time which elapsed before the germs could be used being fatal to about 80 per cent of the material imported.

Improved Method of Inoculation.

A little more than a year ago the investigation of these nitrogen-fixing bacteria was begun in the laboratory of plant physiology of the Bureau of Plant Industry, with the hope of discovering some method of artificially inoculating soils which were devoid of the proper organisms, and of insuring their producing the desired result. It was soon found that the method in use by the German investigators was not adapted to the life of the organism; that is to say, the use of rich nitrogenous food material, such as decoctions of the host plant, were not calculated to produce an organism which would fix free nitrogen from the air. It was found that while the bacteria grew luxuriantly upon such media, they became less and less active, until eventually they lost completely this nitrogen-fixing power. It seemed as though the large amount of nitrates in the media upon which they were grown made it no longer necessary to draw nitrogen from the air, and consequently they deteriorated until they became of no more value than the common soil forms. It has been found, however, that by gradually reducing the amount of nitrogen in the culture medium it is possible to greatly increase the nitrogen-fixing power of these germs, and that by proper manipulation their activity may be increased from five to ten times that which usually occurs in nature. Practical field experiments have shown that of two cultures, one grown on nitrogen-free media and the other on a medium rich in nitrates, the first will produce abundant tubercles, while the latter will be absolutely worthless and fail to produce a single nodule. (See Figs. 5 and 6.)

Distribution and Methods of Use of Cultures.

Having secured an organism which was able to fix such a large amount of nitrogen, it was necessary to devise some means of preventing this property from being lost, as well as to enable the cultures to be distributed in sufficient quantity to be of some practical use. It is now known that the bacteria, when grown upon nitrogen-free media, will retain their high activity if they are carefully dried out and then revived in a liquid medium at the end of varying lengths of time. By using some absorbent which will soak up millions of the tubercle-forming organisms and then by allowing these cultures to become dry the bacteria can be sent to any part of the United States, or the world for that matter, and yet arrive in perfect condition. Of course, it is necessary to revive the dry germs by immersion in water, and with the addition of certain nutrient salts the original number of bacteria is greatly increased if allowed to stand for a short time. Frequently twenty-four hours are sufficient to cause the water in a pail to turn milky white with the number of organisms formed in that time. Thus, by sending out a dry culture, similar to a yeast cake and no larger in size, the original number of nitrogen-fixing bacteria may be multiplied sufficiently to inoculate at least an acre of land. The amount of material thus obtained is limited only by the quantity of the nutrient water solution used in increasing the germs. It is evident, therefore, that the cost of inoculating land is very small. The principal cost is in obtaining the organisms, but the methods perfected by the Department of Agriculture now make it possible to produce these at a comparatively small cost. Special facilities for increasing the culture on a large scale are being provided.

The way in which this liquid culture may be introduced into the soil varies somewhat with the character of the seed to be used and the area of the field to be treated. With large seed it is often more convenient to simply soak them in the fluid and then after they are sufficiently dry to sow them in the ordinary way. In other cases it is frequently more feasible to introduce the liquid culture directly into the soil. This may be done by spraying, or perhaps a simpler method is to mix the culture thoroughly with a wagon load of earth and then to distribute and harrow this in just as a fertilizer would be handled. Inoculations of this character have been tried on a large scale in practical field experiments, and the results have been so satisfactory that the Department of Agriculture will probably soon be able to begin the introduction of cultures into such localities as are now deficient in tubercle-forming germs. It should be borne in mind that such inoculations are usually not necessary in soil that is already producing tubercles. While the introduction of fresh organisms will generally considerably increase the number of nodules, the effect upon the crop is not appreciable, and it is hardly worth the expenditure of time and labor necessary to make the inoculation. Wherever legumes that fail to produce tubercles are being grown, however, or in those localities where the soil is so poor that legumes will not grow and because of the lack of the proper organisms they cannot make a start, every effort should be made to get the bacteria into the soil.

A new use for calcium carbide, for raising and sinking a submarine boat, has been found in Germany. The boat is supplied with an ordinary gas generator and a water tank, the upper part of which is connected with the gas reservoir of the generator. The tank and generator have pipes at the bottom opening into the sea water. The upper parts have vertical pipes for the escape of the gas. If the tank and the reservoir of the generator are filled with water, the boat sinks. After the introduction of a carbide cartridge into the gas generator an immense quantity of gas is formed at once, which forces the water through the lower pipe into the sea. After opening the cock in the connecting pipe, the gas enters the tank and fills it by forcing out the water. The boat now rises to the surface, remaining there until the gas is allowed to escape from both reservoirs, which causes them to be again filled by sea water.

AMERICAN EDUCATION.

THE MOSELY COMMISSION IN THE UNITED STATES.

The London Times's special correspondent with this commission, in his third letter, says:

As our outlook upon American education enlarged, one question already alluded to became even more perplexing—How far is education the cause of American success in commercial and industrial life? We have tried, as opportunity offered, to find out what Americans themselves think of their educational systems, and upon this particular point; but it is not easy for a stranger visiting the United States for the first time and for only a few weeks, to ascertain the real views of thoughtful men in various positions. They all, no doubt, believe in education; they regard liberal expenditure of public and private money upon it as inevitable and right. So far there is general agreement. But when you ask them about results, and about the value, say, of secondary or college education as a preparation for commercial or professional life, opinions vary, so far as I have been able to gather, as much as among ourselves. Those who are concerned in working the educational machine are naturally optimistic. They point with pride to a "mighty fine plant," or "the biggest school buildings" in the States. They know that good work is being done, and they do not hide its light under any bushel of self-depreciation. But even they sometimes express surprise that we in England should expect to learn much from them. I have heard a professor at an American University, where there is a highly-organized system of professorial teaching and post-graduate study after the model of Germany, lament the absence of the tutorial system in vogue at Oxford and Cambridge. I have heard men deeply interested in American "high school" or secondary instruction express strong opinions of its inferiority to our own in the attention paid to the formation of character. Nor have I found business men, so far as I have had opportunities of questioning them, at all unanimous in holding that education is the cause of the superior aptitude and "smartness" of Americans as compared with ourselves. One of the heads of a firm of Wall Street stock brokers, whose office arrangements were a revelation of up-to-date methods and appliances, and who knew something of English business houses and their staff, told me that it was not, in his opinion, education that made the difference, so much as environment and national character, the alertness and resourcefulness derived from the early pioneer days of perpetual struggle against wild Indians and the forces of nature, together with the inventiveness born of necessity. A distinguished American bishop said in my hearing, and in that of a representative gathering of American and Canadian churchmen, apropos of the superiority of Americans in business, that he believed the cause to be mainly climatic; and I had previously heard much the same remark from an intelligent American lady well acquainted with educational matters. "If you English lived in our climate," she said, "instead of in your damp and fogs, you would hustle along, just as we do." This, again, is not all the secret; but there is no doubt something in it, for the influence of climate upon national character is notorious. If the "brave Northeaster," which, as Kingsley tells us, "breeds hard Englishmen," is responsible for some of the stoutest qualities of our race, the exhilarating climate of the New World may have something to do with qualities by which it seems to be distancing us in commerce—and possibly with its greater keenness in taking up the work of education. That keenness, it seems to me, is one of the chief lessons that America has to teach us educationally; and another great lesson is liberal expenditure upon a matter of first-rate national importance. The idea that we must "educate our masters" has been forced upon them sooner and more forcibly than upon us; and they are carrying it into practice further, perhaps, than we shall find necessary.

In saying this, I have more particularly in mind the case of secondary education, in the general diffusion of which we are at present much behindhand. In every American city there exist, or are now springing up, "high schools" magnificently equipped, well staffed, and giving an instruction frequently, though not always or in all subjects, as good as that of our best secondary schools at home; which receive boys and girls of from 14 to 18, after their elementary school course, and carry them on to the college or university. The teachers in these schools have all been properly trained for their work, some of them at the public charge, in normal schools provided by city or state, while others are university or college graduates who have found in such institutions as the Teachers' College attached to Columbia University, New York, opportunity to prepare themselves during a college career for their future profession as teachers. They are fairly well paid—not extravagantly, but better than secondary school teachers in Eng-

land at all except the great boarding schools, in which the stipends depend on that most unsatisfactory and irrational mode of remunerating educational work, the profits of a boarding house. The principal of a public high school in New York, for example, receives, if a man, about £1,000 per annum; if a woman, £750 or £800; while no assistant teacher begins, so far as I can learn, at less than £200 or £250, rising according to age and experience; and, as public servants, all are in due course entitled to retirement on a pension. In Washington, where everything is directly administered by Congress, they are not so well paid. Here, and to some extent elsewhere, the scale of teachers' salaries appears unduly low; and, as a matter of fact, it is not high enough to attract a sufficient proportion of men to the teaching profession, in view of the greater possibilities afforded by business life, to which your smart, "hustling," American youth naturally gravitates. At one normal college for both sexes that I visited in New York not a sixth of the students were men. At the newest and most up-to-date of the high schools at Washington, educating 190 girls and 135 boys, the principal is a lady, with four men and fifteen women teachers under her; and the farther west one goes, the greater becomes the proportion of women to men teachers. No difficulties of discipline, so far as I know, arise; though, were there any, we should not, perhaps, have seen them or been told of them. I can only speak of what we have seen—classes of boys alone, or of mixed boys and girls, from the youngest in primary schools to the upper grades of high schools, kept in apparently perfect order by lady teachers. Whether it be the American boy's greater eagerness to learn, or his natural chivalry to women, that keeps him from "trying it on" with his lady teacher as a Harrow or Eton boy does with a young master, or whether it be that the American lady who becomes a school teacher knows something of her business, while the newly-fledged public school master in England knows nothing of his, I cannot say. Facts speak for themselves; and another lesson which both the discipline and the teaching in American schools drive home to an Englishman is this—that we must do a great deal more than we have ever yet done for the professional training of our teachers. In methods of teaching, I doubt if we have much to learn from them, except in the teaching of English, to which the necessity of perpetual immigration from alien lands compels attention at every stage of the educational ladder, and which in the upper stages is made the basis of very thorough training in thought and expression. The teaching of Latin—though this subject is said to be on the increase—is behind that of our best public school traditions; while all that we have yet seen of the teaching of French and German in the schools is no better than our own—equally out of date, without, apparently, either any knowledge of or attempts to realize, the newer systems of modern language teaching as now pursued in Germany. Speaking generally, I may say the impression made upon some of us thus far is that the best teaching in English schools has little or nothing to learn from America, but that the general average of teaching power, owing to the greater attention paid to the professional training of teachers, is considerably higher than in English secondary schools. But when we look at the diffusion of opportunities for a good education within the reach of every citizen, at the quality of plant and appliances in schools, and at the general spirit and "go" of the whole educational system, backed as it is by the good will of the people, we must confess that we in England sorely need to wake up.

Side by side with the public high school system of America there exist, to a greater extent than might at first be supposed, private "preparatory" or "fitting" schools, to which parents of good means, who prefer it, can send their children on payment of fees—and sometimes very high fees. (A "preparatory" school, by the way, means here one that prepares boys for college, and corresponds to "public" or "grammar" school in England, "public" schools, in American parlance, being the publicly supported schools.) The number of private schools is apparently on the increase; and, as an aristocracy of wealth and comparative leisure grows and begins in practice, if not in theory, to disregard democratic equality, the demand for them will probably grow. Many of them are connected with religious bodies and include in their curriculum systematic religious teaching, which makes them attractive to parents who regret the entire absence of religion from the public school system. After the revolutionary war, when privately managed "academies," as they were called, arose to meet the need for secondary instruction, before the movement for public high schools under the control of state governments had begun, the Jesuits founded institutions for secondary and higher education, as well as conventual schools for girls, and Protestant bodies followed suit. With the growth of public high schools many of these older "academies" disappeared; but some of them still remain and prosper. The two "Phillips Academies" at Andover and Exeter in Massachusetts, founded in the latter years of the eighteenth century, are now well-known private schools, not specially connected with any religious body. Lawrenceville School, in New Jersey, with 400 boys under something like the "house system" of an English boarding school, is an old foundation revived and re-endowed some 25 years ago. St. Paul's School, at Concord, in New Hampshire, with 350 boys; St. Mark's, at Southborough, in Massachusetts, with 125 boys; and Shattuck School, at Faribault, in Minnesota, with 200, are "church" schools, definitely connected with the Protestant Episcopal Church. Situated in country districts, with chapel, boarding houses, and other school buildings, these schools recall many of the features of higher grade secondary boarding schools in England. Like these, they are for people who can afford to pay well, the terms averaging as much as £120 a year, or even more; but some of them, like our public schools, offer scholarships to meet the school fees. Still more select and expensive is a younger institution at Groton in Massachusetts, with fine buildings and costly appliances, the charges at which, as in our own Eton and Harrow, are prohibitive to any but wealthy parents. This school has only been in existence for 20 years. Its success, which probably will lead to other foundations of the same kind, is an incident of that growth, in the midst of the American democracy, of an aristocracy of wealth to which I have before alluded. Some upholders of democratic equality shake their heads over the new development in education, and would have the public schools sufficient for true Americans of whatever position in life. But in this new country there is room for every educational experiment; and, if I were an American, I should look hopefully upon these private "fitting" schools. I should look to them, rather than to the public high schools, to remove whatever truth there may be in the saying of (I think) Mr. Lowell's, that the Americans are "the most common-schooled and the least cultivated people in the world." Not the least educated for the practical purposes of life; owing to the excellent provision of free public education, the average American lad is probably better equipped than the young Englishman.

The public, secondary, or "high" schools in America are free to all; for the theory of American citizenship, that everyone without distinction of party or sex is entitled at the hands of the state to an equal chance in life, logically implies free education from the bottom to the top. In every State of the Union education is provided free up to the age of 18; in some it is carried still further—in State universities. The result is that, of those who are able to allow their children to continue at school above the age of 14, not a few are persons who are able and who, according to English views, ought to pay for their children's education. After visiting the high school at Washington, to which I have already alluded, I found that many of the parents of the boys and girls there receiving their education absolutely free were clerks and other government employes with incomes varying from £300 to £700 a year—people of moderate fixed incomes, to whom the education of their children is in England often a heavy burden, but who with us would disdain to sue *in forma pauperis* for the state to lift that burden altogether from their shoulders. Here we have one of the cases in which, as President Roosevelt truly reminded us, the institutions of one country cannot be transferred to another. Our aim, in the reforms which we trust are coming at the hands of our new local authorities, should be to place within the reach of all who desire it, in towns and as far as possible in country districts, good sound secondary education at moderate charges, at the same time providing by a judiciously organized system of scholarships a "capacity-catching" machine that shall enable all who are fit to rise from lower stages to find the means of obtaining higher education and so doing the best for themselves in life. A country in which, through the slow march of centuries, society has become more or less crystallized into horizontal strata with a distinctly marked social classification is very different from one in which all are in theory still equal in rights, in capacities, and in opportunities. America stands committed to both the theory and the practice of free education of the best type accessible to all. We may well imitate all the accessibility and some of the quality of American education; but we need neither imitate nor envy the environment which has made the offer of free education to every citizen, whatever his position in the only social hierarchy known there, the hierarchy of wealth, a logical necessity.

THE LANDOLPHIA OF FRENCH CONGO YIELDING CAOUTCHOUC.*

In the interior of Africa, on the table lands, where woodland has been cleared off by fires, Landolphia are found, of a very different type from the climbing plants of the forest. Their roots are freely developed underground, but the stalks aboveground, periodically burned off, produce an annual or biennial plant. It remains dwarfed, often herbaceous, and as it has no need of clinging to trees, it is not provided with tendrils.

These creeping herbaceous plants furnish caoutchouc from their roots, which fact has been discussed very much lately, without knowledge of their botanic origin.

On the table lands, in the neighborhood of Brazzaville, we have observed three species of these plants belonging to the family of the Landolphia.

The most commonly met with is the *Carpodinus lanceolatus* (K. Schum), the herbaceous stalks of which, having a length of from 15 to 40 centimeters, cover all the dry table lands around Stanley Pool.

This species is mingled with low grasses, belonging mostly to the genus Andropogonia. The *Smilax Kraussiana*, and a large asparagus with rough shoots, are frequently found in these places. The *Pteris aquilena* also abounds here. In smaller quantity are the two Landolphia which will be described hereafter. All these plants have vigorous root-stalks, which penetrate the ground deeply. At the end of the dry season, the portions of these plants above ground are usually burned off, and even the seeds are often destroyed. Many of the plants (particularly the Landolphia) bear, at the extremity of a very slender stalk, one or two heavy fruits, which at maturity bend the stalk until it touches the ground. At the time of the fires the ashes of grasses and the remnants of plants cover the fruits, forming a protection from burning. The seeds thus buried are in excellent condition for germinating.

The *Carpodinus lanceolatus* (K. Schum) has already been partly described. The young shoots are of a beautiful bluish green; the flowers growing at the end of a stem, from one to six in number, are white and blossom in July. The fruit ripens in August or September. It is yellow, having the size and form of a large lemon, mammilated on top, occasionally almost spherical. The exocarp is sometimes smooth, but oftener covered with excrescences; these seeds, numbering from five to seven, are surrounded with an esculent pulp. Besides the usual type, we have observed the two following varieties:

Var. angustifolia var. nov.—The full-grown leaves are flat, from 7 to 10 centimeters long, and from 8 to 10 millimeters wide, decurrent at the base and pointed at the opposite end, eight or nine times as long as they are wide; the plant is mingled with the type found at Brazzaville.

Var. latifolia var. nov.—The full-grown leaves are lanceolated, from 9 to 12 centimeters long, and from 2 to 3 centimeters wide, four times as long as wide; this variety is also mingled with the typical plant of Brazzaville.

It is a mistake to regard the *Carpodinus lanceolatus* (K. Schum) as a caoutchouc plant. The sap of its roots and branches yields on coagulation only resin. The creeping plant yielding caoutchouc most abundantly is the *Landolphia Tholloni*, described by A. Dewevre in 1895. It has been named later *Clitandra gracilis*. We pointed out this species in 1901 as a caoutchouc plant.

The *Landolphia Tholloni* is a small shrub with many branches; it is from 15 to 30 centimeters in height, and without tendrils.

The leaves have a foot-stalk, are small, lanceolated, from 30 to 65 millimeters long and from 8 to 16 millimeters wide, rough on the upper side and smooth underneath. The blossoms, few in number, are white and grow in clusters of from two to ten. The fruit is almost spherical at maturity, 5 centimeters in diameter, and sometimes covered with small, flat, corklike spots, due to the action of the fires. The seeds are surrounded with a sweet esculent pulp.

The branches aboveground do not contain caoutchouc in their latex, but the old roots underground yield it in abundance. These roots grow to a length of from 6 to 10 meters, running horizontally, and at certain distances throwing up stalks aboveground. The diameter of the roots varies from 4 to 10 millimeters. The sap is in the bark, coagulating after desiccation, yielding excellent caoutchouc, which so far has not been turned to account. This plant is found in such quantity that in some places the roots form in the ground an inextricable network. We have gathered as much as four kilogrammes of fresh roots from a space of six square meters, and a part of the roots were broken off and still remained buried. The plant constitutes a latent wealth in all those portions of Congo where it exists.

The third species also yields caoutchouc. M. Schlechter, who first discovered it, has named it *Landolphia humilis* R. Schlechter nom. nud.

The horizontal underground root-stalks, buried to a depth of from 15 to 20 millimeters, at certain distances throw up shoots aboveground, which are short and slender, growing from 0.30 to 0.50 meter in height, grayish, marked with numerous lenticels, nearly always without tendrils, and downy at the base. The leaves have a foot-stalk, are leathery and lanceolated, blunt at the end, from 8 to 10 meters long, and from 4 to 5.5 centimeters wide; with a foot-stalk, which measures from 4 to 6 millimeters, covered with short down, especially on the upper side. The flowers bloom in clusters from five to thirty in number, having a tube corolla, five millimeters long, yellowish white, and swelling toward the middle. The ripe fruit is of orange color, occurring singly or in groups of two or three, almost spherical, having a longitudinal diameter of from 4 to 5 centimeters. The fruit is tapering, and contains from four to five seeds within an esculent, sugary pulp. This plant is very common at Brazzaville, on the cleared table land. A plant of the group Eulandolphia, similar to *L. Heudelotii* and *L. owariensis*, belongs undoubtedly to this species.

It is possible to confound with the *L. owariensis* the following variety: *L. humilis Schlechter* var. umbrosa var nov., with stalks rising to 3 meters in height, and having tendrils and large lanceolated leaves, which on an average are 13 centimeters long and 6 centimeters wide (attaining occasionally a height of 17 centimeters and a width of 17 centimeters), very leathery, and of dark green color when fully grown. The flowers of some grow in clusters, while others are cirriform. The fruit resembles that of *L. owariensis*, but is smaller. At Brazzaville it is commonly found in shady places and in the clearing of forests.

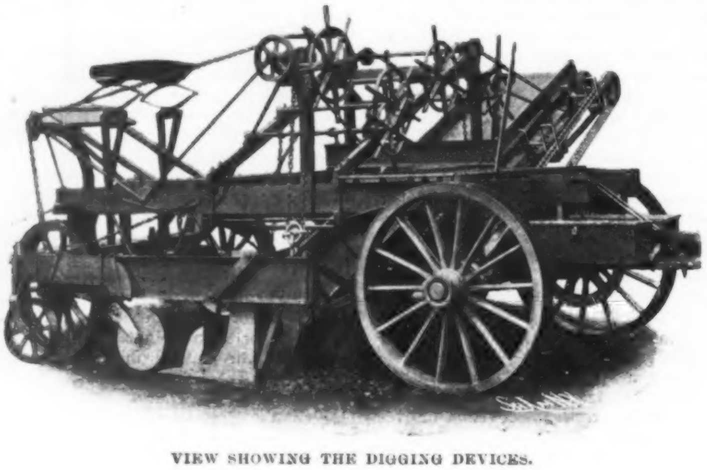
The *Landolphia humilis* and its varieties do not contain caoutchouc in the aerial parts, but in their roots, although in smaller quantity than the *L. Tholloni*.

We propose to determine the industrial value of these plants.

* From the French of Aug. Chevalier. Paper presented to the Académie des Sciences.

A NEW GRADING AND DITCHING MACHINE.

Much has been said and written on the subject of the American supremacy in the railroad field, and elaborate arguments, backed up by statistics, have been brought forth to prove the statement that the United States has made most rapid strides in the extension and improvement of its railroad methods. In this connection it is interesting to note that while various



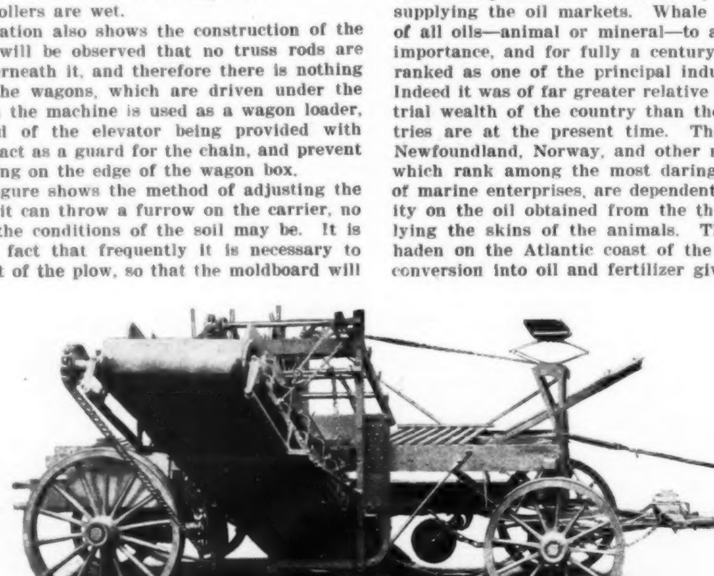
VIEW SHOWING THE DIGGING DEVICES.

causes have been assigned for the extent of our railroad systems, little attention has been paid to the conditions which have made it possible to accomplish in this country, in a comparatively short time, projects which in other countries would be the work of years, for the reason that American railroad contractors have employed labor-saving machinery, where some of the older countries have stuck to the obsolete hand methods.

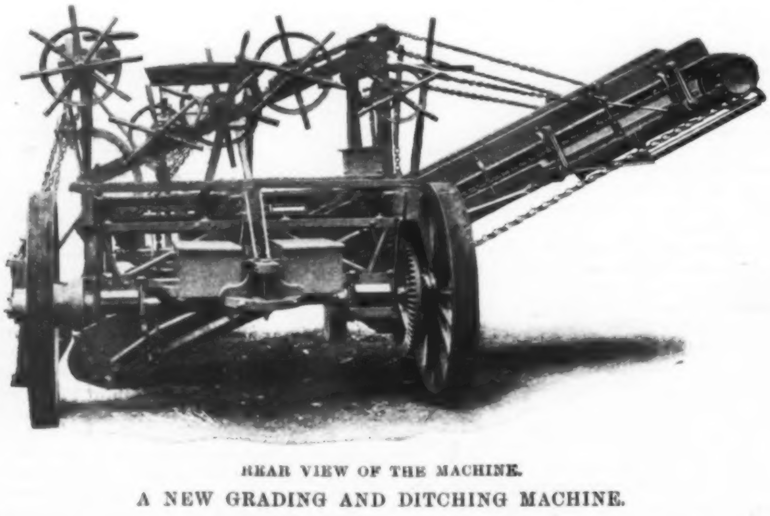
Of all the labor economizers which have a place in a railroad contractor's outfit, probably the simplest and most efficient is the elevating grader. It will therefore be interesting to railroad builders to learn that an improved elevating grader has been put on the market by the National Drill and Manufacturing Company, of Chicago, Ill., who claim that their new machine possesses certain features which overcome many of the difficulties encountered in the operation of machinery of this class.

Those who are familiar with elevating graders in general, are aware that heretofore the entire draft of the plow has been brought either directly or indirectly onto the machine. This, of course, has been a drawback to its successful operation in many classes of soil, and has necessitated the expenditure of a great deal more power than should really be required to move the amount of earth handled. The new device employed on the National elevating grader overcomes this difficulty. It will be observed that the draft of the plow itself is carried direct on the evener, being transmitted by a heavy draft chain which passes the kingbolt and is hooked to plow standard. Reference to the illustration shows that this chain is intercepted in front of the elevator by a spreader bar, which can be raised or lowered as the conditions require, thus regulating the angle of the pitch which is assumed by the plow point. This is an important feature, particularly when plowing in hard ground, and it must be borne in mind that after a plow is gaged to the required pitch, it is not necessary to give it any further attention, as the spreader beam holds it in position permanently.

A new device is also used for adjusting the elevator, namely, a turnbuckle brace running from the side of the elevator hanger to the elevator itself. This is a valuable feature when it is necessary to straighten a belt which has stretched unevenly and is running crooked.



SIDE VIEW OF THE MACHINE, SHOWING BELT.



REAR VIEW OF THE MACHINE.

A NEW GRADING AND DITCHING MACHINE.

One of our illustrations shows the rear view of elevating grader, and the hand wheels and levers for controlling and regulating the machine in operation. The center hand wheel is employed for spooling up the two lines of chain that tighten the belt. This is a decided improvement over the old method of tightening by a lever, as it is absolutely unlimited in its scope. In fact, the makers claim that the only limit which this belt tightener has is the strength of the belt itself. Those who have operated elevating graders in wet, slippery soil, particularly when loading wagons, are fully aware of the difficulties which have been met in attempting to keep the belt tight, as it has invariably been the case that the belt would slip more or less as soon as the rollers are wet.

This illustration also shows the construction of the elevator. It will be observed that no truss rods are required underneath it, and therefore there is nothing to catch on the wagons, which are driven under the elevator when the machine is used as a wagon loader, the outer end of the elevator being provided with rollers which act as a guard for the chain, and prevent it from catching on the edge of the wagon box.

The third figure shows the method of adjusting the plow, so that it can throw a furrow on the carrier, no matter what the conditions of the soil may be. It is a well-known fact that frequently it is necessary to change the tilt of the plow, so that the moldboard will scour. This has been done formerly by a complicated scheme involving a number of castings and bolts, which must be first loosened and the castings then adjusted more or less by guess until the proper pitch is found. It is possible in this machine to tilt the plow at the will of the operator without requiring him to leave his position on the platform. This is accomplished by means of a hand lever on the extreme right, working in conjunction with a slide underneath the machine, and the tilting upright riveted to the rear end of the plow beam. It is therefore possible to adjust the plow to a fractional part of an inch, and lock it in any position which seems most effective.

The general frame of the machine is built of heavy timbers, reinforced wherever required by steel rods and trusses, so that strength and durability are obtained. A second reference to the illustration affords a good example of this point. It will be observed that the elevator is carried above a yoke, which forms a continuous tie underneath the elevator and prevents any sagging of the frame. There are a number of other features in this machine, which are interesting to those engaged in railroad or electric traction line construction, about which the manufacturers will be very willing to give information.

AQUATIC PRODUCTS IN ARTS AND INDUSTRIES.

By Charles H. Stevenson.

The diversity and magnitude of the industries based on the utilization and manufacture of aquatic products are not fully appreciated. In a previous publication of this Commission* the great variety of fishery products used for food and their methods of preparation were discussed. In addition to the numerous items of food articles, the materials employed in the arts and industries compare favorably in variety and interest with similar products of the land. These may be roughly separated into five classes, viz., (1) oils, fats, and waxes; (2) fertilizers from aquatic products; (3) skins of aquatic animals and their products of furs and leathers; (4) the hard substances, as shells, scales, bones, ivories, etc., and (5) miscellaneous articles not properly classed with any of the foregoing, as glue, isinglass, seaweeds, sponges, marine salt, etc. The total value of the annual product of these throughout the world roughly approximates $45,000,000 in the condition in which they are first placed on the market, of which the United States contributes $11,000,000.

Some of the most extensive fisheries of the world have been prosecuted almost wholly for the purpose of supplying the oil markets. Whale oils were the first of all oils—animal or mineral—to achieve commercial importance, and for fully a century the whale fishery ranked as one of the principal industries of America. Indeed it was of far greater relative value in the industrial wealth of the country than the petroleum industries are at the present time. The seal fisheries of Newfoundland, Norway, and other northern countries, which rank among the most daring and venturesome of marine enterprises, are dependent for their prosperity on the oil obtained from the thick blubber underlying the skins of the animals. The taking of menhaden on the Atlantic coast of the United States for conversion into oil and fertilizer gives employment to thousands of men and to several million dollars of capital. And in the various cod fisheries of the world the rendering of the livers into oil for medicinal as well as for technical uses is a source of great profit. In addition to these extensive industries there are numerous minor fisheries supported entirely, or to a large extent, by the oil markets.

From all varieties of aquatic oils may be separated, at a low temperature, a solid fat or grease known as "foots" or "stearin," somewhat similar to the tallow obtained from sheep and oxen. This is obtained in the process of refining the oils, and the yield ranges from 3 to 20 per cent of the bulk of the crude oil. It is sold at a few cents per pound, and is used as a substitute for tallow from sheep and oxen in sizing yarns, as emollient in leather-dressing, and for various other technical purposes.

Bleaching the various marine oils produces a semi-solid fat known as "sperm soap," "whale soap," "menhaden soap," etc., according to the variety of oil treated. This material is used in smearing sheep, washing fruit trees, soap-manufacture, etc.

In the process of refining sperm oil, instead of the foots, the wax-like spermaceti is obtained, the quantity yielded approximating 11 per cent in weight of the crude sperm oil. Spermaceti is used principally in candle making, as an ointment for medicinal purposes, for producing a polish on linen in laundering, and for self-lubricating cartridges.

Another wax-like substance peculiar to the sperm whale is ambergris, an extremely valuable substance found at rare intervals, but sometimes in comparatively large quantities within the intestines of that animal, and also afloat on the sea or cast up on the shores. A single whale has yielded $50,000 worth of this material, and several instances are reported in which $20,000 worth has been obtained from one cetacean. Ambergris was formerly used as an incense, in cookery, as a medicine, and as a perfume. Its principal use at present is in the preparation of fine perfumes.

* The Preservation of Fishery Products for Food, Bulletin U. S. Fish Commission, 1898.

The principal aquatic products used for fertilizer are seaweeds, shells of mollusks and crustaceans, non-edible species of fish, especially the menhaden, and waste parts of edible species. At present the quantity of this fertilizer produced annually in the United States alone approximates 420,000 tons, worth $2,120,000. This is capable of very great increase, especially in the quantity of seaweeds and waste fish employed.

Doubtless 50 per cent of the world's stock of furs is obtained from aquatic animals. Formerly this percentage was greater, but it is reduced by the decrease in product of beaver, fur-seal, otter, and sea-otter, and the large increase in quantity of certain land fur-bearers. Fully 75 per cent of all the furs produced in the United States are yielded by aquatic animals, principally the fur-seal, mink, muskrat, beaver, otter, and sea-otter. The value of the annual output of these in the United States approximates $2,500,000 in the raw or undressed state.

Leather is made from the skins of practically all the aquatic mammals and of most of the species of fish, but these usually rank among novelty or fancy leathers. Seal leather is produced in large quantities, the value of the annual product averaging $1,500,000.

The hide of the beluga, or white whale, is one of the best of all skins for leather purposes, on account of its durability, strength, and pliability. It is sold as porpoise leather, and probably $200,000 worth of tanned hides are marketed annually. Alligator skins are also

The yield of whalebone in the United States fisheries is less than 5 per cent as much as it was fifty years ago, but the reduced yield has been largely counterbalanced by the increase in value per pound. The product in the American fisheries now approximates 120,000 pounds each year, worth $500,000, and about $150,000 worth is obtained in all other parts of the world. At the present market price the total value of whalebone secured in the United States fisheries since 1850 is not far from $200,000,000.

Comparatively little tortoise shell is produced in this country, the annual yield approximating $12,000 in value. The West Indies, South America, Africa, East Indies, Pacific islands, etc., supply probably $500,000 worth each year, much of which is manufactured in the United States.

Little economic use is made of fish scales, except in the production of artificial pearls and other ornamental objects. Unique and attractive artificial flowers are made from the scales of sheepshead, tarpon, drum fish, channel bass, etc.

Cuttlebone and coral are not produced in the United States, but large quantities are imported into this country.

The yield of ivory in the form of walrus tusks, sperm whale teeth, etc., is small at present, amounting to less than $25,000 annually.

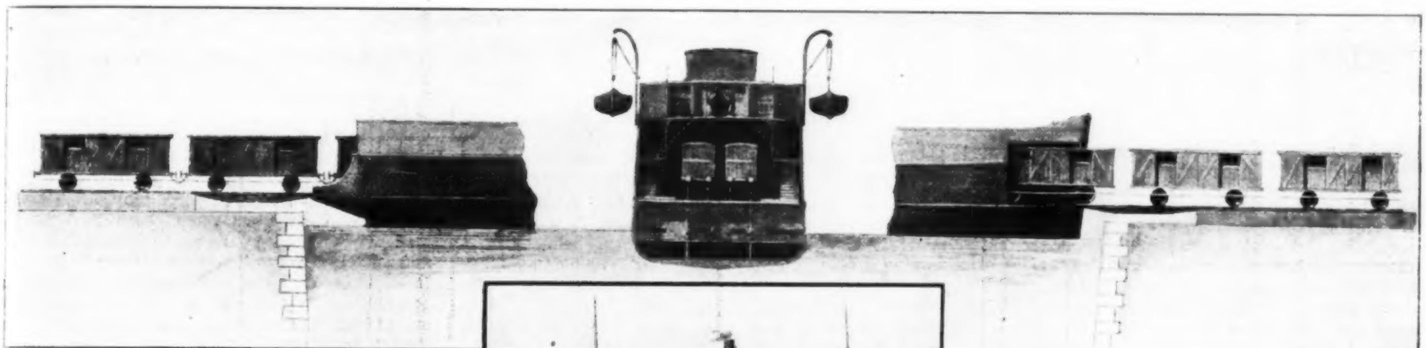
The principal industrial use for bones of aquatic animals is for conversion into fertilizer. Several va-

cod and other species, but it has not yet been extensively manufactured.

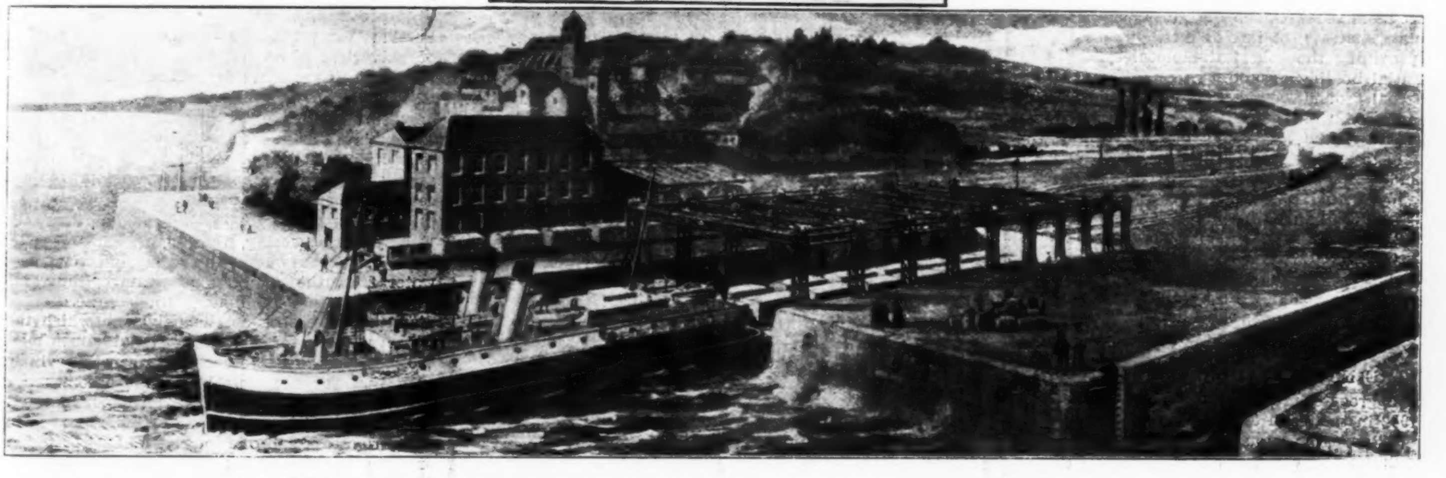
The preparation of oils and fertilizers, to which the present report is devoted, is intimately associated, especially in the case of the menhaden industry. The tissues remaining after the extraction of oil from herring and other waste fish, from the blubber of seals, porpoise, and the like, from the livers of cod and related species, the livers of sharks, from the waste parts of fish in dressing, etc., are commonly prepared for fertilizing purposes, and the preparation of the two materials is usually carried on in the same factory and in some instances by the same workmen. For this reason it appears desirable to combine in one paper the account of the preparation of oils and fertilizers from aquatic products. This paper, however, is divided into two parts, one relating to the preparation, characteristics, and uses of fish oils, fats, and waxes, and the other to the utilization of aquatic products as fertilizers.—United States Fish Commission Report.

A CROSS-CHANNEL SYSTEM OF TRAIN-FERRY-BOATS.

According to the Illustrated London News, a system of cross-channel train-ferryboats has been proposed by the Intercontinental Railway Company. The trains are to be run on board a steamer, by which they will be bodily conveyed across the channel. The accompany-



SECTIONS SHOWING THE POSITION OF THE EMBARKATION BY THE STERN AND TRAINS ON BOARD, AND THE METHOD OF DISEMBARKATION BY THE BOW.



THE METHOD OF DEPRESSING AND RAISING THE PLATFORM TO RUN THE TRAINS ABOARD THE VESSEL.

A PROPOSED SYSTEM OF CROSS-CHANNEL TRAIN FERRYBOATS.

obtained in large quantities, and owing to the peculiarity of their markings, are used entirely as fancy leather. Tanned walrus hides, especially the thick ones, are in great demand for polishing wheels and other mechanical purposes, and about $100,000 worth are sold annually. Among the aquatic skins used to a less extent for leather purposes may be mentioned sea-lion, porpoise, sea-elephant, and a very large variety of fish skins, especially those of sharks.

Of the hard substances existing in the form of shells, bones, scales, etc., shells are by far the most important. Nearly, if not quite, 1,000,000 tons are secured annually in the United States, consisting principally of the shells of oysters, clams, river mussels, and a very much smaller quantity of other varieties. A fair valuation of these at the places of consumption would doubtless amount to $1,500,000; to this should be added about $600,000 as the value of pearls secured during the last year in the Mississippi Valley and elsewhere.

The value of the shells secured outside of the United States, principally mother-of-pearl shells, amounts to $5,000,000 or $6,000,000 annually, and the pearls secured sell for nearly an equal amount. Pearls are not obtained in the seas in such large quantities as formerly, but their value is greatly increased. The manufacture of mother-of-pearl and sweet-water shell in the form of buttons, buckles, knife handles, pistol stocks, etc., gives employment to nearly 10,000 persons in this country and to probably three times that number in Europe and elsewhere.

rieties of curious bones are used for ornamentation, but their aggregate value is inconsiderable.

The sponge output of Florida approximates $500,000 annually, and the value of the product throughout the world is probably not far from $5,000,000.

The uses of seaweeds are numerous. They furnish thousands of tons of fertilizer, many nutritious foods, and a variety of chemicals, especially iodine and bromine. Other uses are in sizing fabrics, as a mordant in dyeing, in refining beer, in making paper, fishing lines, ropes, for stuffing upholstery, packing porcelain, etc. The Japanese have been especially adept in discovering uses for seaweeds.

Glue manufacture provides an outlet for the profitable use of much waste in dressing dried codfish. This material was formerly discarded as useless, but now tens of thousands of dollars worth of choicest glue for postage stamps, court plaster, adhesive paper, labels, envelopes, for mechanical purposes, and for sizing of straw goods and textile fabrics, and likewise office and domestic mucilage are manufactured from fish skins. The product is very much stronger and more durable than glue made from the skins of mammals.

Isinglass made from the sounds or swimming bladders of sturgeon, hake, cod, squeteague, etc., is used for clarifying fermented liquors, the cellular construction forming a sort of net which carries down floating particles. However, the use of this material has been much reduced, owing to the numerous substitutes obtained from domestic animals.

Commercial albumen may be made from the eggs of

ing illustration shows the method of raising and lowering the platform in order to run the trains aboard the vessel. The platform at the harbor can be raised or lowered by pulleys, to adjust the rails to the height required by the tide. The small picture gives a general view of the proposed ferry steamer.

WHAT TO DO WITH MOLDER'S SAND.

The characteristics of a sand well suited to the iron molder's hand should be flexibility, permeability, and freedom from fusible substances.

By flexibility we mean that it should possess the property of lending itself without resistance to the pressure put upon it from any direction and, when once formed to suit the requirements, retain its shape even after the moisture has been driven off, in spite of slight jars or contacts. A sand, the particles of which are rough and pointed, having a sharp, gritty feel, will best answer these demands.

In the molding, the projections of one grain will grip into the depressions of another and hold it. A little clay and water added to such sand will increase its flexibility to a marked degree.

The clay supplies the adhesive property and the water constitutes the lubricant. Where suitable natural sand cannot be had within convenient reach, an inferior quality may, by the addition of a smooth clay and a good grinding up, be made very suitable. Sand free from all clay becomes flexible when moistened, but does not retain its molded shape so well. Too

much water must, of course, not be added; for instance, the sand should not be moist enough to stick to the hand, yet when it is pressed into a ball it should be so firm that it is possible to pick off a pinch at a time without the whole fabric falling apart or flattening out by its own weight.

Permeability is required of the sand to permit the free passage of the gases and steam which are generated as soon as the molten metal is poured into the mold. These gases must be expelled through the form-walls; if they do not find exit that way they are likely to cause blisters, air holes or pockings on the surface of the casting, or if they penetrate the flowing liquid, force it out. Permeability depends upon the size of the grains and it is much better the nearer the particles are of a uniform measure. Dustlike parts stop up the pores, as does also the clay. Still the permeability must not be so free that the metal itself may find its way into the pores.

In this respect the quality of the sand used depends much upon the nature of the casting to be made; machine work—rough casting, as it is called—may be done with much coarser sand than art casting.

The presence of substances that fuse at the temperature of molten iron is deleterious because they take hold of the sand and with it form glass-fluxes. These rob the form-walls of their porosity, burn on the surface of the casting and make its smoothing difficult.

All molding sands possess this inconvenient characteristic to a greater or less degree. It is more apparent as the melting temperature of the metal rises, and the longer the mold is subjected to the intense heat. Effort has been made to overcome this by mixing with the sand ground hard-coal, which contains little ash, but much gas. This powder gets between the individual grains of sand and when touched by the molten iron generates gas, forms into coke and, by holding the grains apart, retains the porosity of the whole. Experience alone governs the quantity of coal dust to be added; much depends upon the qualities of the sand, the amount of clay in the mixture, the size of the casting, and the volume of sand in use.

The burning of the glass fluxes on the casting may in a measure be hindered by covering the surface of the mold with an infusible substance, at least fusible at a much higher temperature than it will meet when in contact with the liquid iron.

Graphite, charcoal, and coke reduced to powder have been found serviceable for this purpose. After dusting out the mold with one or the other of these powders the surface may be smoothed with the proper tool, to be sure that the powder will stick. Graphite powder is by far the best for smooth castings, but it does not remain in position so well as the others; to secure this it must be mixed with charcoal dust, whose needle-like particles penetrate the face of the mold and stay there, thus providing the spherical molecules of graphite a substantial holding ground.

Charcoal ground wet is best for this purpose. Sand once used loses much of its flexibility. The excessive heat cracks off the points and the clay is burned by it; it is said to become lean. This loss is dependent upon the kind of sand. For reasons of economy, however, the sand is used over and over again, but must be reinvigorated by grinding and the addition of new sand. A machine is best adapted for mixing the sand and the coal dust. A prime molding sand for use in moist molds is made by mixing 2 volumes of fat (clayey, loamy) sand with 1 volume of sand already used and ½ volume of ground hard coal.—Translation from Erfahrungen und Erfindungen.

THE NAPHTHA INDUSTRY OF BAKU.

The aggregate production of naphtha during the year 1902 in the Baku district amounted to 637,000,000 poods (62 poods = 1 ton). The following table shows the production of the previous years:

	1900. Poods.	1901. Poods.	1902. Poods.
From spouting wells.	67,800,000	101,400,000	94,700,000
Pumped	532,900,000	573,200,000	542,300,000
	600,700,000	674,600,000	637,000,000

The considerable decrease for last year occurs principally in the pumped naphtha, and more especially in the Balachany and Bibi-Eihat oil fields. The springs of the oldest and largest worked oil fields at Balachany yield less and less every year, and the great depth of the bore-holes entails additional cost. At Bibi-Eihat the cause of the decrease is mostly to be looked for in the high government fees on the naphtha sites. The decrease in the output at Seabuntschi, through the failing of spouting wells, is counterbalanced by a corresponding increase in the output of spouting wells at Romany. Also in the installation of new bore-holes there is a distinct retrogression, which will appear from the following table (for the first eleven months of each year):

New Bore-holes.	1901.	1902.
Commenced	265	158
Completed	335	224
In state of boring.........	843	540
Older bore-holes deepened..	300	230

Compared with this decrease in boring, the decrease of only 5.6 per cent in the output must be looked upon as very favorable. The export from Baku was very considerable, the excessive supply of liquid fuel causing some trouble at the distributing centers on the Volga. At regards quantity, the Nobel Company still heads the list with 78,100,000 poods, which is not much less than the previous year, while two or three other firms show a very material decrease compared with 1901.

ELECTRICAL NOTES.

Many ancient and historic buildings are now losing some of their antiquity by the introduction of the electric light, whose subtle encroachments apparently no hand can stay. Among the latest to succumb to the anachronistic illumination of electricity is no less a venerable pile than St. Peter's at Rome. The installation has recently been completed. Current is supplied at 2,000 volts alternating, and is reduced to a lower voltage by transformers situated in a chamber on the level of the main cornice round the dome. The interior lighting consists of 628 incandescent lamps of 25 c. p., and a large number of others of 10 c. p. The total illumination at present is 14,000 c. p. The installation, however, is capable of being increased to a maximum of 80,000 c. p. An interesting feature of the work is that the high-frequency mains are two miles in length, while the copper wire used in the building itself extends to a total length of 15 miles.

Dr. Dawson Turner recently lectured before the Royal Scottish Society of Arts on the risks attending the use of radium in medical science. For instance, radium emanations for consumptives have been suggested, but Dr. Turner strongly warns patients not to attempt such a remedy without previous medical sanction. The human tissues are very susceptible to radium rays. It is unsafe to carry radium about in one's pocket. Several cases are on record of inflammation and ulceration of the skin following such a procedure. Even the carrying of it in a glass tube from one patient to another may set up inflammation similar to that induced by an improper use of the Röntgen rays. Any ulcer formed by it may last for weeks or months. The chief physiological effects of radium so far as at present investigated can be arranged in three groups: (1) Effects on the skin, producing inflammations and ulcers; (2) effects on the nervous system, producing paralysis and death; (3) luminous effects produced in the partially blind.

It is quite apparent that if wireless telegraphy is practically operative at all, it should be feasible to apply it as a means of communicating to and from moving trains. Hence we hear of various inventors who are assiduously applying themselves to accomplish this result, seemingly without asking whether, if their efforts should be successful, there would be any demand for such a system of inter-communication. It is not novel to accomplish such a result. It was done long ago by Phelps, Edison and others by induction telegraph methods in a very simple and successful manner, but there was no demand for it; and it is, therefore, not likely that a system not nearly so simple, economical, or, it may be assumed, reliable, will create such a demand. Another somewhat unnecessary proposed employment of wireless telegraphy has recently been proposed and tested, namely, for automatic fire alarm telegraph purposes. For this work nothing could well be more simple, reliable and practical than the ordinary wire circuit connecting the building to be protected with firemen's headquarters. Such an alarm system, to be of any practical utility, must give automatic evidence of some kind when defects of any sort arise; or it must be feasible to test the circuits and apparatus at regular intervals. All this is readily done from headquarters by the existing wire telegraph systems, with little or no complications at the protected building. With wireless telegraph apparatus, however, a complete transmitting and receiving system would be necessary at each protected building to effect the results just mentioned, the cost of which would, doubtless, be many times more than the cost of a connecting wire. Besides, who is to keep the coherer, induction coil, battery, and other accessories in adjustment night and day in the various stations? The moral of which remarks is, why waste time, energy and money in demonstrating that certain things can be done by wireless telegraphy when they can be, and are, done much more satisfactorily by other means?—Cassier's Magazine.

A rare surgical operation of which there are, it is said, only nine recorded cases, consists in applying an electric current directly to the aorta, the main artery of the body. The operation, called the "Corridis operation," is not used extensively on account of its extreme danger to life, only three out of the nine cases operated upon having survived. An operation of this kind was performed recently, say the Western Electrician, on a man in Philadelphia, who was suffering from an aneurism or dilatation of the aorta, which extended 3 inches above the base of the breast bone, and was 3½ inches wide. To save the patient's life it was necessary to reduce the aneurism, and to do that the hospital physicians had recourse to the "Corridis operation." The operation was performed by Prof. E. W. Holmes, surgeon-in-chief at the Samaritan Hospital, assisted by Drs. Tietrich, Snively and Finch of New York. Many men prominent in the medical profession were spectators. As no severe pain was attached to the method used in treating the patient, he was not put under the influence of an anæsthetic. A hollow porcelain needle was introduced, and a section of gold wire 15 feet long was passed through the hollow of the instrument and permitted to coil in the diseased region. The wire was then connected with a galvanic battery and the circuit was completed by the placing of a negative plate in connection with the patient's back. As soon as these preliminaries, which occupied 15 minutes, were completed a current of 5 milliamperes was turned on. This was increased at regular intervals until it had attained a strength of 80 milliamperes and one hour's time had elapsed. The treatment seems to have been successful and the patient is said to be doing well. The object of the operation is to produce a coagulation of the blood at the diseased part, and the danger lies in the chance of small portions of the coagulated blood passing on through the arteries to other portions of the body, where they will clog up the smaller channels and cause the death of the patient. By the use of electricity Dr. James Brien, Essex, Ont., says that he has restored life to a child which had apparently been born dead. A slight pulsation was noticed immediately on the birth of the child, but it gradually grew fainter and fainter until not a sign of life remained. It was fully 15 minutes after the birth before the first electric current was employed. After 15 minutes of the application of the current the infant showed signs of returning life. The current was increased persistently, and in 10 minutes more the child was said to be breathing and the heart beating normally.

ENGINEERING NOTES.

An experiment was recently made in Switzerland to determine that there were different degrees of temperature in steam boilers, and a Scotch boiler was used in the trial. It was found that the upper part of the boiler was 159 deg. Celsius hotter than the lower part, and that after two hours there was very slight change in the temperatures. This experiment would have been more satisfactory if several types of boilers had been tested, for the peculiarity noted in the case of the Scotch boiler has been known for a long time, and it is one of the chief objections to its use as a generator.

The Sylvester system of waterproofing concrete, which has been in use for about sixty years, consists in applying a solution of alum and soap to the surface of the concrete. A modification of this process has been used with favorable results on fortification work as follows: To 2 gallons of water add 1 pound of concentrated lye and 5 pounds of alum, and mix thoroughly until every particle is dissolved. This is a concentrated mixture and should be diluted before using by adding to 1 pint of the mixture 10 pounds of cement, and sufficient water to make a wash that will lather freely under the brush. Two coats of this wash should be applied—the first coat as soon as the forms are removed from the concrete. It should be applied with a kalsomine brush evenly and thinly, since when it is too thick it will scale off. The second coat can be applied at any time after the first coat is dry. If the surface of the concrete is dry it should be wet down with a brush ahead of the wash. Another modification of the Sylvester process consists in adding to the mortar, which is used for facing, the alum and the soap used for waterproofing. In preparing such mortar use 1 part Portland cement to 2 parts sand, and add ¾ of a pound of pulverized alum for each cubic foot of sand, and mix these ingredients dry; then add the proper quantity of water, in which has been dissolved ¾ of a pound of soft soap to the gallon of water, and mix thoroughly. Such mortar is little inferior in strength to ordinary mortar of the same proportions; it forms an excellent waterproof coating, and prevents efflorescence.—Mines and Minerals.

Steam Pumps in Mines.—Steam pumps at mines are usually direct acting, that is, the steam piston acts directly on the water piston or plunger to force the water from the pump. The steam cylinder is larger in diameter than the water cylinder, the differences in diameter increasing as the height to which the mine water must be forced increases. At mines more than 350 feet deep the differences between the cylinders are such that for economical work it becomes necessary to use steam expansively in a compound pump, that is, a pump with two steam cylinders, one for high-pressure steam and one for the exhaust from the high-pressure cylinder. This system saves steam and therefore power which otherwise would be lost. Further, the steam needed to work a deep-mine pump not compounded would create too much heat in the mine, even if the exhaust were let into the pump. Objections to the use of steam pumps in mines are numerous, but these can nearly all be overcome by proper appliances. The loss of steam through condensation by carrying it through pipes from the surface into a mine can be decreased by the use of proper steam-pipe covering to prevent the radiation of heat. In one instance on record the steam is carried 3,000 feet from the boilers in pipes. One of the duties, therefore, in the care of pumps at mines is to see that the steam pipes are properly and thoroughly covered, and if through accident they become uncovered the covering should be immediately replaced. This applies to all countries, no matter what the temperature may be. The disagreeable effects arising from steam exhausting into the mine atmosphere are overcome by condensing the exhaust. There are two methods of disposing of the exhaust from mine pumps, viz., to condense the steam in the sump, or in the tail-pipe. The method followed depends on the depth of the mine, for in deep mines, on account of the difference between steam and water cylinders, the volume of exhaust steam is out of proportion to the volume of water pumped; and if the water from the condenser flows directly into the sump water it will increase the temperature to a degree that would cause annoyance, damage the timbering, and besides detract from the effectiveness of the pump and condensers. By discharging the condensed steam directly into the suction pipe of the pump, the warm water is removed as fast as produced, and the sump water remains cool.—E. B. Wilson in an article in Mines and Minerals.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Opportunities for American Trade and Enterprise in Liberia.—Owing to the absence of direct steam communication between the United States and Liberia the trade between the two countries is practically nil as compared with the trade between Liberia and Great Britain, Germany, France, and Holland.

Liberia produces many articles similar to those which the United States imports in large quantities, viz., coffee, palm oil, camwood, ginger, cacao, and piassava. There are great forests of rubber trees in the country, the British concessionnaires controlling the industry.

The Anglo-African Argus and Gold Coast Globe notes that the palm oil shipped from Liverpool to the United States for the first six months of 1892 represented a total of 5,200 tons, entered at the following ports: New York, 2,595 tons; Boston, 1,243 tons; Newport News, 963 tons; Philadelphia, 385 tons; and Baltimore, 14 tons.

The African League (local journal of Monrovia), commenting on the importation of palm oil into the United States, says:

"This shows to what extent West African produce is used in the United States, or at least this particular West African product.

"It should be remembered by our friends and merchants in the United States that probably no part of West Africa is more productive of palm oil than Liberia; therefore, if there were direct steamship communication between the United States and Liberia the former would not have to buy through the agency of Liverpool, but it could buy directly of Liberia, shipping it on the Americo-Liberian steamer.

"Not only could palm oil be shipped from Liberia to the United States, but thousands of tons of rubber could be shipped from the rubber fields of Liberia to the great ports of America where it is so extensively used. Rubber is a great staple in Liberia and is destined to be one of the greatest exports of the black republic.

"Not only in these, but in her lumber industry is she destined to rank first among the West African States. Her dense forests of mahogany trees of itself make Liberia great in the lumber industry. Besides mahogany, there is a wood in Liberia—a kind of ironwood—of which it is said there is hardly any end to its durability. Another very useful class of timber is the African pine, as also the African gum tree, and many other kind of trees useful in the lumber industry. Hence, lumbering in itself will finally form an important industry in Liberia, and her exports along this line will bring large returns of wealth to this nation."

The statement relative to rubber in the foregoing extract is misleading, as an English syndicate has a monopoly of the rubber industry; but the wealth of Liberia in forestry is all and more than the league claims.

A concession for the development of the Liberian lumber industry can be obtained by any substantial American syndicate.

A like opportunity offers for the cultivation of cotton in Liberia. Within the last two or three years the Germans in Togoland, and the English in Lagos, have been experimenting in cotton growing with good results, and as Liberia is in the same physical belt as Lagos there is no reason why similar results should not be obtained from like efforts. The natives have, from time immemorial, raised cotton and made their own cloth, hence there need not be any "experiment" outlay.

Liberia just now holds the attention of the mining world. While the American capitalist and mining investor has lost much by inactivity and lack of interest in the known mineral resources of this republic, there are yet fields for profitable investment left open to investment.

Not only gold, silver, copper, tin, coal, and iron are found in Liberia, but diamonds have recently been discovered. The right to prospect and mine in Murtsenado and Maryland counties has been granted to the West African gold concessionnaires of London, but the Bassa and Sinoe counties are as yet unoccupied. By the agreement between the government of Liberia and the West African concessionnaires there is no close monopoly, as every other plot or block in the territory named is reserved to the government.—James Robert Spurgeon, Chargé d'Affaires at Monrovia, Liberia.

American Shoes in Vienna.—The opening within a few weeks of a large retail shoe store in the center of Vienna's shopping district where only American-made shoes will be sold is a significant tribute to the superiority of American shoes. Shoemaking is one of the Austrian industries which has always flourished and which enjoys a considerable export trade. Sales of American shoes in the Austrian market have, therefore, met with many difficulties, and there has been until recently a more or less general belief among Austrians that competition with the Austrian product in the home market could not be successful, both on account of the good quality and the cheapness of the home-made shoes. Besides, public opinion and government influence favor protecting the home industry. The growing demand for American-made shoes which has now resulted in the establishment of a shoe store in which American shoes are to be sold exclusively proves conclusively, however, that American footgear has made its way into public favor strictly on its merits, and that the trade is likely to have a steady increase in the future.

American shoes have been sold in Vienna during the last few years in small quantities with gradually increasing success, being handled by a number of stores side by side with Austrian shoes; but up to the present time there has been no store where there was a large stock to select from, and the test of the market has, therefore, not been wholly satisfactory. The project to do business on a larger scale has been undertaken by the proprietors of a leading Viennese shoe store who have during the last two years bought small consignments of American shoes experimentally. They have now become satisfied that there is a permanent and growing demand for these shoes that warrants catering to the wants of Viennese buyers on a more extensive scale, and they have decided to open a separate store to be known as the American Shoe Store of Vienna. A large store has been rented for this purpose, and the first order to American manufacturers is for 3 000 pairs of shoes. The men back of this enterprise are successful Viennese dealers in shoes, thoroughly in touch with the market, and they consider the success of their new venture assured. Their customers to whom they have sold American shoes are so pleased that they will never again wear shoes of any other make.

American shoes impress Austrian buyers as possessing far greater durability, superior comfort, and better workmanship. They are more expensive than the Austrian article, but customers are satisfied to pay more, as they consider them worth more. The Austrian shoes, though handmade, are admittedly inferior to the American machine-made shoes.

It is interesting in this connection to note that Austrian manufacturers have sought to imitate American methods, having imported American shoemaking machinery, but they have been unable even by this means to produce shoes equal in quality to those made in the United States.—W. A. Rublee, Consul-General at Vienna, Austria.

American Agents in Foreign Countries.—Having occasion to write to an American manufacturing company and not knowing the address of the London agency, I suggested that, though it might not seem worth while sending their London address to consuls, it might pay them, as they advertised extensively in American magazines, to insert the address of their London agency in their advertisements in such magazines as have a good sale in this country, and when advertising a special article quoting prices to give the prices in English money. Upon receipt of my letter this American concern wrote:

"We beg to thank you for your information in regard to American magazines and their circulation in England, and are calling the attention of our London manager to this matter."

The London agent wrote me a letter which indicated that the communication he had received from his firm had puzzled him greatly. Replying to the agent's letter, I wrote:

"I have only to say that I suggested to your home office that the several American magazines which are sold somewhat extensively in this market should have at the bottom of their American advertisements the address of the English agent of advertisers and quoted prices should be in English money, and having read my letter carelessly your home concern wrote me that they had 'called their English department's attention to the matter;' but as the advertisements are placed in magazines in the United States and by the home office, I have written them asking what good it would do them to call their English department's attention to the hint I had given them. This is but an instance of the many cases in which an American consul finds it difficult to be of assistance to the manufacturers of his country."

The London agent, in reply, said he was taking up the matter with the home firm, asking them to include his address in their advertisements, and intimated that my letter would assist him in getting them to do so. He concluded his letter as follows:

"I have for many years been with our company and am constantly exerting my best efforts on behalf of their export business, which I am sorry to say so few American manufacturers understand; but I have no doubt the time will come when they will pay closer attention to the requirements of foreign trade."—Marshal Halstead, Consul at Birmingham, England.

American Meats and Dried Fruits in Germany.—Protests against the action of police authorities in seizing or forbidding the sale of American dried fruits because they contain an admixture of sulphuric acid are made in the annual reports of many chambers of commerce throughout Germany. The chambers claim that not a single case has occurred where injury resulted from said admixture. On the contrary, it is said it helps to preserve the fruits, which are a popular article of food. The Chamber of Commerce of Mannheim, in conjunction with many other chambers of commerce, addressed the imperial sanitary bureau at Berlin on the subject of "American dried fruits" and the police orders inhibiting their sale. The chamber refutes the allegation that the use of sulphuric acid as a preserving means is injurious, and petitions the sanitary bureau to fix the amount of acid allowable in the preservation of these fruits, which are necessary articles of consumption.

The report of the Mannheim Chamber of Commerce speaks also of the scarcity of the meat supply and the greatly lessened consumption of beef and pork, owing to their high prices forcing the working classes to eat horse flesh.

The report of the chamber of commerce for the state and city of Hamburg says on the subject of the restrictions on the importations of meats that the restrictions are Agrarian measures, instituted for the purpose of forcing high prices for domestic meat, and are not justifiable on sanitary grounds. It mentions particularly "corned beef," against which nothing can be alleged as being hurtful to consumers, and it quotes the opinions of experts to show that the small amount of boracic acid used for the preserving of the meat is not injurious and is actually indispensable. The chamber instituted inquiries among the Hamburg shipowners, who said that since foreign canned meats have been used on their vessels the health of the crews has been much improved, but after trial it was found that the canned meat put up in Germany is inferior to the foreign article. The report further expresses the hope that the federal government will soon realize the fact that by keeping out cheap foreign meat a serious injury is done to the working classes of Germany and that such injury must create intense feeling and strengthen the Social-Democratic party.—Simon W. Hanauer, Deputy Consul-General at Frankfort, Germany.

Discovery of Coal in Honduras.—A discovery of a large coal bed has been made in the mountains of the Department of Yoro, in Honduras. The prospective coal field has been named "El Porvenir." Expert examination and test of several samples of the coal taken from or near the surface establish the claim that it cokes with excellent result. All the samples were taken from the outcroppings of the vein, where the surface water has been running over the bed during a great many years, and consequently the presence of decomposed matter materially lessened the value of the results of the various tests. But coal taken from a depth of two feet or more exhibited much better qualities, being firm and lustrous. It is therefore believed that at a depth of from 50 to 100 feet the deposits should be found to possess all the requisites of first-class coal. The foot wall is said to be formed of silicate aluminium and magnesia, a formation, it is said, frequently encountered beneath coal beds.

The results of the examination seem to warrant the opening of these mines. As there are no other coal fields of value in this part of the continent the exploitation of this property should carry with it profitable returns, as well as inaugurating a new industry in a region now but sparsely populated. The projected railways, and such lines as are now in operation both in this and adjoining republics, would receive direct impetus through the opening of these coal fields. All coal is at present brought from the United States.

The section in which the coal field is located is remote from railroads or other means of transportation, and the profitable operation of mines would require the building of railroads to get the product to markets; but present and prospective demands will justify the necessary expenditure if development of the field gives assurance of an adequate supply of coal of good quality.—Alfred K. Moe, Consul at Tegucigalpa, Honduras.

Opening for American Steel in Italy.—The Italian Navy Department has announced its intention of purchasing navy supplies, armor plates in particular, from firms in foreign countries if the Italian steel manufacturers' combination, a kind of trust, attempts to raise the prices of such materials. American steel and iron manufacturers should pay careful attention to the Italian markets, as those of Germany are doing. The quantities of steel and iron which Italy proposes to use in the immediate future will, perhaps, be more than the home industry can supply and will, therefore, necessitate large orders being awarded to foreign contractors.—Brainard H. Warner, Jr., Consul, Leipzig, Germany.

American Leather and Shoes in Belgium.—United States Consul J. C. McNally, of Liege, Belgium, under date of October 14, 1903, notes the importation of considerable quantities of American leather into Belgium, and says there is a constant demand for American shoes, concerning which he reports:

I find it impossible to secure a pair of fine American shoes either in Brussels or Liege. I would think that in such large cities an American shoe house would do a good business, as shoes of United States manufacture are acknowledged to be superior to all others.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

TRADE NOTES AND RECIPES.

The following is recommended by the Pharmaceutische Zeitung to prevent the freezing of shop windows: Dissolve 2 ounces of glycerine in 1 quart of 62 per cent alcohol containing, to improve the odor, some oil of amber. When the mixture clarifies it is rubbed over the inner surface of the glass, and, it is claimed, it not only prevents the formation of frost but also prevents sweating.

To Bronze Brass.—The Deutsche Metallarbeiter is authority for the following method of bronzing brass: Immerse the articles, freed from dirt and grease, into a cold solution of 10 parts of potassium permanganate, 50 parts of iron sulphate, 5 parts of hydrochloric acid in 1,000 parts of water. Let remain 30 seconds, then withdraw, rinse off and dry in fine, soft sawdust. If the articles have become too dark, or if a reddish brown color be desired, immerse for about one minute into a warm (60 deg. C. or 140 deg. F.) solution of chromic acid 10 parts; hydrochloric acid, 10 parts; potassium permanganate, 10 parts; iron sulphate, 50 parts; water, 1,000 parts. Treat as before. If the latter solution alone be used the product will be a brighter dark yellow or reddish brown color. By heating in a drying oven the tone of the colors is improved.

New and Strong Cement.—The Seifenfabrikant gives the following: Pour over well-washed and cleaned casein 12½ parts of boiled linseed oil and the same amount of castor oil, put on the fire and bring to a boil, stir actively and add a small amount of a saturated aqueous solution of alum; remove from the fire and set aside. After standing awhile a milky-looking fluid will separate at the bottom and arise to the top. This should be poured off and to the residue add 120 parts of rock candy syrup and 6 parts of dextrin.

To Bleach Sponges.—The Färber und Wascher gives the following: Wash the sponges in plain water, then plunge them in water carrying 10 deg. of hydrochloric acid and leave them there for 24 hours. Wash them again in plain water, then throw them into bromine water (water, 1,000 parts; bromine, 4 parts) and leave them for 24 hours, when they will be found to be perfectly white.

Handsome Ornamental Effect.—To a strong solution of silver nitrate in crystals in distilled water, add sufficient mucilage of gum arabic to prevent the liquid from flowing when applied to a fabric. Now on a bit of silk or fine linen with a quill pen (or a camel's hair or sable pencil may be used) draw a flower, or a group of them, or, in fact, any suitable design, using the silver nitrate solution as an ink. Let the fabric dry spontaneously, and when dry hold it, face downward, over a vessel in which nascent hydrogen is being generated (by means of scrap or granulated zinc in dilute sulphuric acid). The hydrogen commences at once to reduce the silver, and it is deposited on the fabric, to which it attaches itself firmly. In a very few moments the entire design is reproduced in metallic silver, and the bit of fabric thus ornamented forms an elegant book mark or ornament.—National Druggist.

Amount of Energy Required by the Osmium Lamp.—We learn from the German technical press that a company, organized in Berlin, has begun the manufacture of the new osmium lamps invented by Dr. Auer von Welsbach. The claim is made that these lamps do not require a greater energy to operate them than 1.5 watts per candle, which, if true, affords a marked saving, about 50 per cent. over the lamps in ordinary use, which consume energy equal to 3 or 3.5 watts under the same conditions.

A table of figures has been published concerning the longevity and efficiency of these lamps, based upon certain experiments carried out by Mr. Remane, one of the company's engineers.

For example: A lamp of 39 volts consumed at first 1.54 watts per candle, producing a light the luminous intensity of which equaled that of 33 candles. After being in operation 500 hours, the candle power dropped to 32.4, while the lamp absorbed only 1.49 watts; but after burning 1,000 hours at the same voltage, the light-giving power did not exceed 31.7 candle power, with a return to the consumption of 1.5 watts per candle.

Experiences like these reveal a curious anomaly in the action of the osmium lamp; its efficiency increased in some cases at the end of a certain number of burning hours. However, the reverse was the case with the lamp of 55 volts, which gave at the start a luminosity equal to 34.7 candles, while it absorbed 1.43 watts per candle. After burning 1,000 hours the light from this lamp descended to 31.6 candle power. At the same time the consumption of electric energy ran up to 1.58 watts; but another test with a lamp of 53 volts disclosed a consumption of energy equal to 1.51 watts at the beginning and 1.44 watts at the end of the experiment. This phenomenon appears to be of an altogether irregular nature; but in every case the efficiency is remarkably high. The comparative action of two osmium lamps and two lamps of the ordinary carbon filament, each of 32 candle power, connected in a current of 55 volts, proved a most interesting test. The first two worked with 0.9 ampere, while the other two required 1.8 amperes for their proper functioning, charges which plainly show the difference of energy absorbed. The light from the osmium lamp is of a beautifully clear white, somewhat resembling that from the Nernst lamps.—Translated from Science, Arts, Nature.

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TABLE OF CONTENTS.